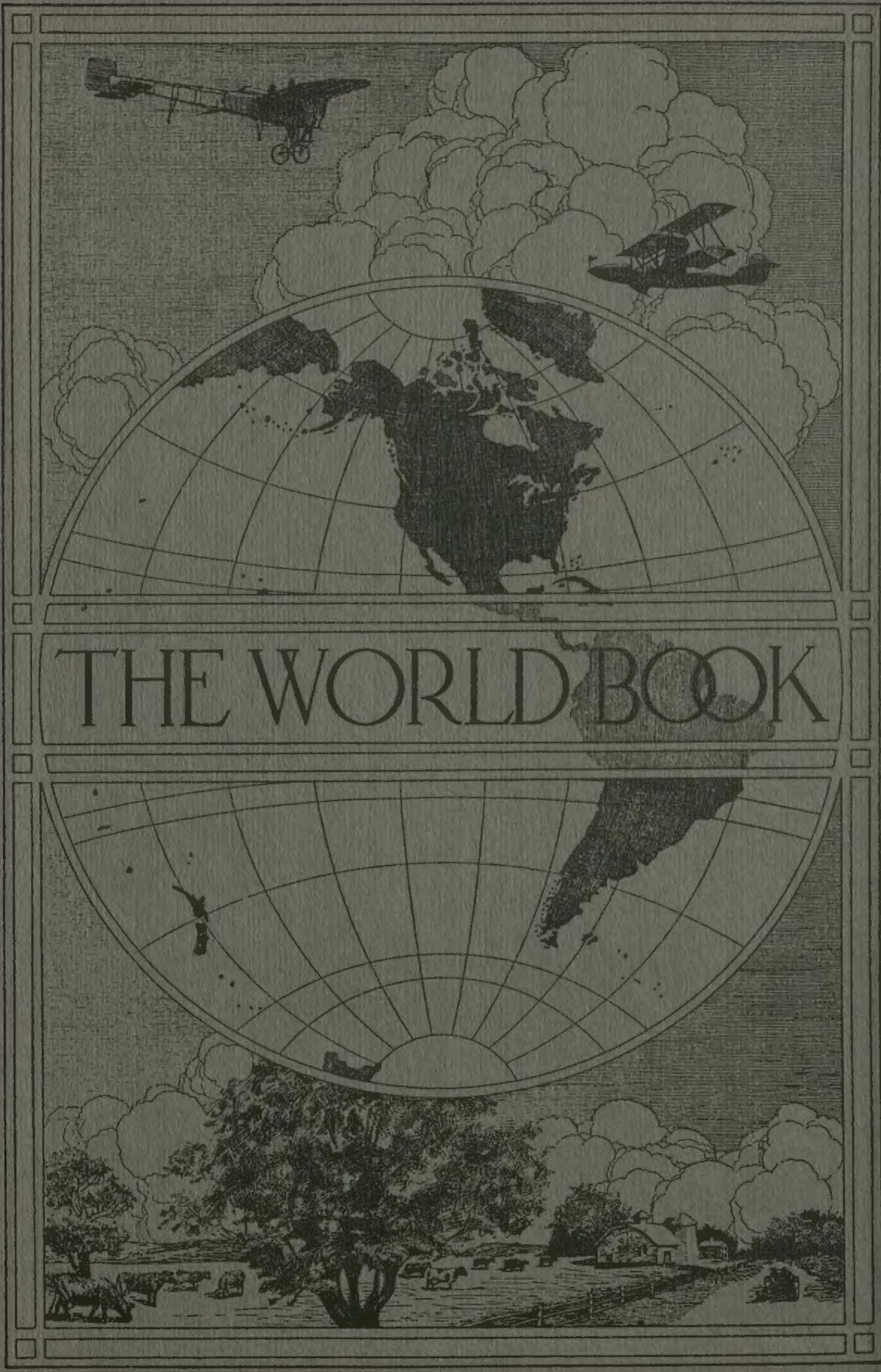
THE WORLD BOOK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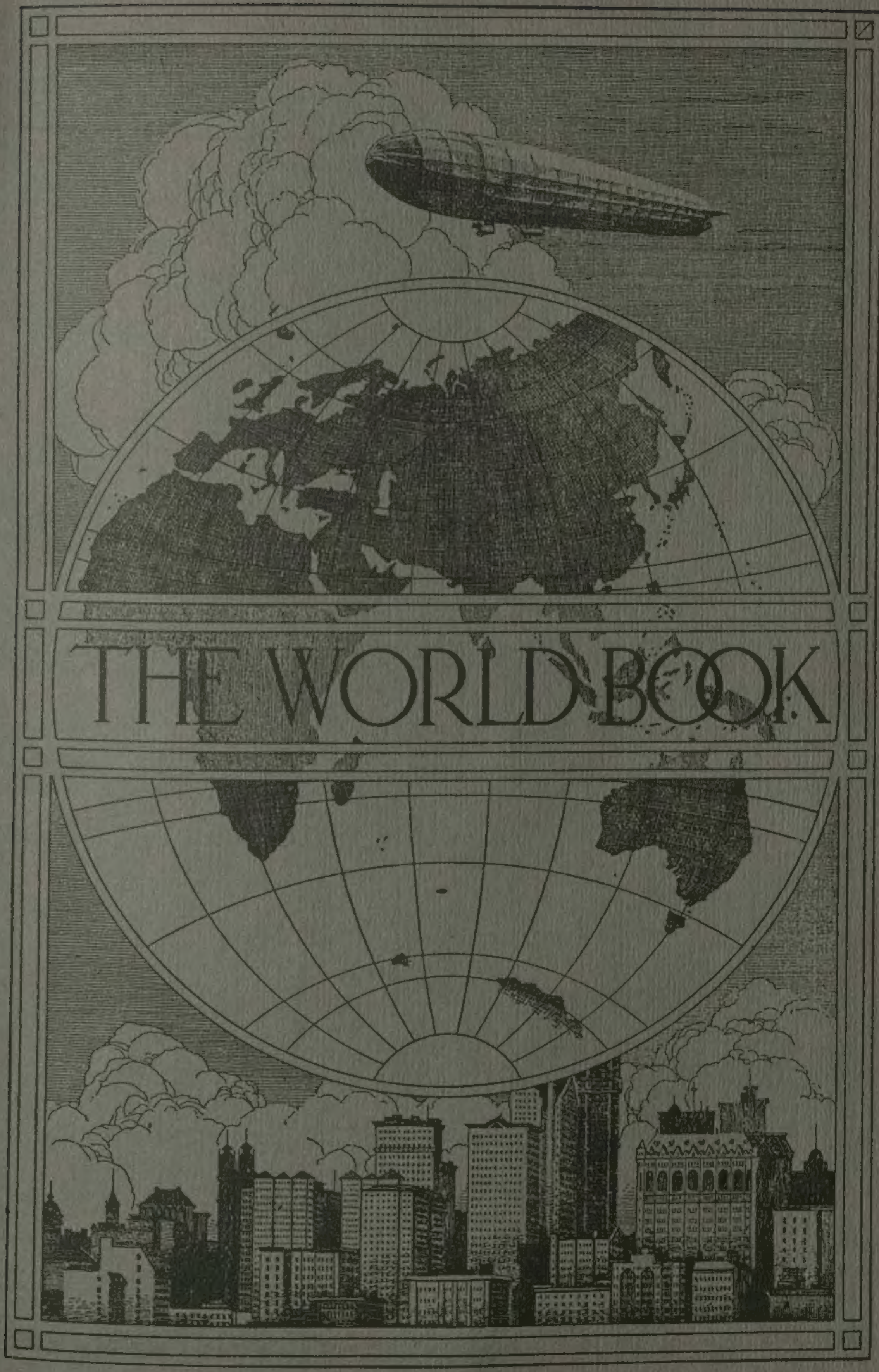

THE WORLD BOOK

P Volume 15



# The World Book Encyclopedia

**World Book International**
World Book Inc.
A Scott Fetzer company
London Sydney Tunbridge Wells Chicago

The World Book Encyclopedia
(International)





"World Book" Reg. U.S. Pat. & T.M. Off. Marca Registrada

ISBN 0-7166-6696-0

Library of Congress Catalog Card Number 95-61137

Printed in the United States of America

1 2 3 4 5 99 98 97 96

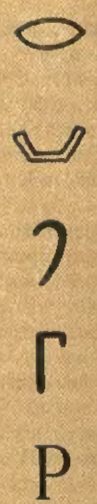
# Pp

**P** is the 16th letter of the English alphabet. It was also a letter in the alphabet used by the Semites, who once lived in Syria and Palestine. They named it *pe,* their word for *mouth,* and adapted an Egyptian *hieroglyphic,* or picture symbol, for *mouth* to represent it. The ancient Greeks took the letter into their own alphabet and called it *pi.* The Romans adopted the Greek alphabet and developed the letter form used today. See **Alphabet.**

**Uses.** *P* or *p* is about the 18th most frequently used letter in books, newspapers, and other printed material in English. In chemistry, *P* stands for *phosphorus. P* is used as an abbreviation for *post,* as in *P.S.* for *postscript.* Post comes from the Latin word for *after,* and we also use it in *p.m.,* or *post meridiem,* for afternoon. In bibliographies, *p* stands for *page;* in money, *p* stands for *penny* and for *peso,* a unit of currency in Spanish-speaking countries. In grammar, *p* represents *past* and *participle.* In music, it stands for *piano,* an Italian word that means *softly.*

**Pronunciation.** In English, a person pronounces *p* by closing the lips and the velum, or soft palate, and temporarily stopping the breath passage. The vocal cords are apart, and do not vibrate. The typical sound of *p* occurs in such words as *pie* and *pen.* The combination *ph* is often sounded as *f* in such words as *physics* and *photograph. P* is silent in such words as *pneumonia* and *psychiatrist.* The letter has always had much the same sound. See **Pronunciation.**

### Development of the letter P



**The ancient Egyptians** used this symbol for *mouth* about 3000 B.C.

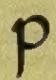
**The Semites,** about 1500 B.C., adapted the Egyptian symbol. They used it for the letter *pe,* their word for *mouth.*

**The Phoenicians** used a rounded, hook-shaped letter about 1000 B.C.

**The Greeks** squared the hook and added it to their alphabet about 600 B.C. They named the letter *pi.*

**The Romans** gave the P its present shape about A.D. 114.

**The small letter p** appeared during the A.D. 600's. By about 1500, the letter had developed its present form.



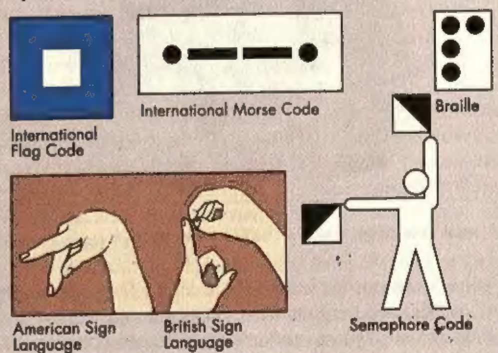
A.D. 600

p

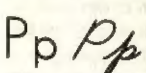
Today

### Special ways of expressing the letter P

P




### Common forms of the letter P



**Handwritten letters** vary from person to person. *Manuscript* (printed) letters, *left,* have simple curves and straight lines. Cursive letters, *right,* have flowing lines.

Pp *Pp*

**Roman letters** have small finishing strokes called *serifs* that extend from the main strokes. The type face shown above is Baskerville. The italic form appears on the right.

Pp *Pp*

**Sans-serif letters** are also called *gothic letters.* They have no serifs. The type face shown above is called Futura. The italic form of Futura appears on the right.

P

**Computer letters** have special shapes. Computers can "read" these letters either optically or by means of the magnetic ink with which the letters may be printed.

**Paarl** (pop. 73,415), a town in the Western Cape Province, is the third oldest colonial settlement in South Africa. The first farms were laid out in 1687. The town itself dates from 1720. A municipality was established in 1840. Paarl is an important wine-making centre.

The town was given its name by Abraham Gabbema, a Dutch settler, who recorded that glistening, granite boulders in the area resembled shiny pearls ("paarl" in Dutch). Paarl Mountain consists of three huge granite *outcrops* (bare rock formations)—Paarl Rock, Britannia Rock, and Gordon's Rock. The Khoikhoin people referred to the mountain as "Tortoise Mountain."

Paarl is an important area in South African history. *Huguenots* (French protestants) settled in the district in 1688. South Africa's oldest church building, constructed in 1805, stands in Paarl. The first newspaper in the Afrikaans language was published there in 1876. A monument to the language dominates Paarl Mountain.

**Paca** is a large rodent found in the tropics of North and South America. Pacas measure 60 to 80 centimetres long. Most pacas weigh between 6 and 10 kilograms.

Pacas have a small, thick head; stout body; short, slender legs; and short tail. There are five long toes on each back foot and four on each front foot. Pacas are covered with rough, brownish or black hair. Four rows of white spots line each side of their body. Pacas have unusually large cheek pouches. The pouches form roomy chambers that help the animal make sounds.

Pacas are found from central Mexico south to Paraguay, and in the Andes Mountains of Venezuela, Colombia, and Ecuador. They live in forests, usually near rivers. Pacas are good swimmers and often escape from enemies by water. Most pacas live alone in burrows, caves, woodpiles, stumps, or rocks. Most females produce two litters a year of one or two young.

**The paca is a large rodent that lives in forests.**

Pacas come out for food only at night. They eat plants, roots, seeds, and tropical fruit. Pacas also eat sugar cane, maize, and yams, and are often hunted in areas where these crops grow. Hunters also kill pacas for their tasty flesh. Wild dogs and ocelots also prey on pacas.

**Scientific classification.** The paca belongs to the family Agoutidae. The two most common species are *Agouti paca* and *A. taczanowski.*

**Pacelli, Eugenio.** See Pius XII.

**Pacemaker.** See Heart (Abnormal heart rhythms); **Medicine** (picture: A pacemaker); **Epilepsy.**

**Pachomius, Saint** (290?-346), a Christian monk from Egypt, founded the first Christian religious communities called *monasteries.* Pachomius organized the first monastery in 320. He eventually established nine monasteries for men and two for women.

Pachomius' monasteries were groups of connected buildings walled off from the outside world where monks and nuns lived under militarylike discipline. Pachomius emphasized manual labour, *ascetic* (self-denying) practices, common prayer, and strict obedience to the monastery's leaders. He developed regulations, called a *rule,* to meet the economic and spiritual needs of his monastic communities. Pachomius' rule became the model for all later monastic rules, notably those prepared by Saint Basil and Saint Benedict. In 404, Saint Jerome translated Pachomius' rule into Latin. In this form, it significantly influenced the development of monasticism in the West.

Pachomius was born near Isna, Egypt. He converted to Christianity in about 313 and became a hermit. His feast day is May 14.

See also **Monasticism** (Christian monasticism); **Religious life** (The Roman Catholic Church).

**Pachyderm** is one of the *pachydermata,* a zoological classification that has been abandoned. This group included such noncud-chewing, hoofed mammals as the elephant and rhinoceros.

**Pacific Islands,** also called Oceania, is the name given to a group of many thousands of islands scattered across the Pacific Ocean. No one knows exactly how many islands are in the Pacific. Geographers estimate that there are from 20,000 to more than 30,000. Some islands cover thousands of square kilometres. But others are no more than tiny piles of rock or sand that barely rise above the water.

Some islands in the Pacific do not belong to Oceania. Islands near the mainland of Asia, such as those that make up the countries of Indonesia, Japan, and the Philippines, are considered part of Asia. Islands near North America and South America, such as the Aleutians and the Galapagos, are grouped with those continents. Australia is itself a continent. These areas are part of what is called the Pacific Rim.

Although some islands of Oceania are large, all of them together cover less than 1,500,000 square kilometres. New Guinea is the largest island in the group and the second largest island in the world, after Greenland. New Zealand's two main islands are the second and third largest islands in Oceania. Together with New Guinea, they make up more than four-fifths of the total land area of the Pacific Islands.

Oceania can be divided into three main areas: (1) Melanesia, (2) Micronesia, and (3) Polynesia. These areas are based on the geography of the islands and on the culture and ethnic background of the native peoples. See the map *The three main areas of Oceania* in this article for the islands that make up Melanesia, Micronesia, and Polynesia.

*Melanesia* means *black islands.* Its name is derived from the word *melanin,* which is a blackish or brownish pigment produced in the skin. The Melanesian people have large amounts of melanin in their skin, which makes their skin dark. Melanesia includes New Guinea, the Solomon Islands, New Caledonia, and Vanuatu. Fiji is considered part of Melanesia because of its location. However, its culture is more like that of Polynesia. The Melanesian islands lie south of the equator.

**The spectacular scenery of the Pacific Islands** attracts many tourists. The cable car in the foreground carries visitors on a breathtaking ride across Pago Pago Bay in American Samoa.

***Micronesia*** means *tiny islands.* These islands lie north of Melanesia, and most of them also lie north of the equator. More than 2,000 islands make up Micronesia. Most of them are low-lying coral islands. Micronesia includes Guam, the Caroline Islands, the Mariana Islands, the Marshall Islands, the Gilbert Islands, and the single island of Nauru.

***Polynesia*** means *many islands.* It occupies the largest area in the South Pacific. There are long distances between its island groups. Polynesia stretches from Midway Island in the north to New Zealand, 8,000 kilometres to the south. The easternmost island in Polynesia, Easter Island, lies more than 6,400 kilometres east of New Zealand.

The land and climate differ greatly throughout the Pacific Islands. Many of the islands, especially those in Polynesia, are famous for their sparkling white beaches, gentle ocean breezes, and swaying palm trees. Some other islands, especially in Melanesia, have thick jungles and tall mountain peaks. Many lowland areas in these islands are steaming hot, but the tallest mountain peaks are covered with snow throughout the year.

About 12 million people live in the Pacific Islands. Only a few islands or island groups, such as Fiji, Hawaii, New Guinea, and New Zealand, have large numbers of people. Many islands have fewer than a hundred people, and others have none at all. The first Pacific islanders came from Southeast Asia several thousand years ago. Their earliest settlements were in Melanesia and Micronesia. Most of Polynesia was settled later.

Over a period of thousands of years, a variety of cultures developed in the Pacific Islands. This variety resulted in part from the varied environments on the different islands. Most of the islanders traditionally lived in small villages and fished or farmed for a living. They knew nothing of what went on in the rest of the world, and the rest of the world knew nothing of them. Then in the 1500's, the first Europeans arrived in the Pacific. By the late 1800's, several European countries and the United States had taken control of most of Oceania.

Europeans and Americans brought their own ways of life to the islands. As a result, the islands have two ways of life today. There is the new way, brought by Europeans and Americans, and the old way, handed down for hundreds or thousands of years. Many islands now have busy, rapidly growing towns and cities much like those in Europe and North America. But most people still live in villages, and many of them follow the same way of life their ancestors did.

New Zealand and Hawaii differ from the rest of Oceania in many ways. New Zealand is an independent, highly developed country and has a modern economy. Most of its people have a European background. Hawaii is a state of the United States and, like New Zealand, has a modern economy (see **Hawaii; New Zealand**).

This article deals mainly with the other islands of the Pacific. At one time, most of them were ruled by other countries. But many of the people on these islands felt that the ruling countries had taken much more from the islands than they had given in return. Beginning in the early 1960's, a growing number of islanders demanded the freedom to govern themselves. As a result, today most islands or island groups are independent or have some form of self-government.

# *People*

**Population groups.** Some scientists divide the people of the Pacific Islands into three population groups—Melanesian, Micronesian, and Polynesian. Melanesians, *left,* have the darkest skin. Micronesians, *centre,* have a somewhat lighter skin. Polynesians, *right,* are the tallest and lightest skinned.

The first settlers in the Pacific Islands probably came from Southeast Asia thousands of years ago. They reached the islands by means of rafts or dugout canoes and followed land bridges whenever possible. One group of settlers, the *Melanesians,* travelled eastward from Indonesia, keeping south of the equator. Another group, the *Micronesians,* spread across the western Pacific north of the equator. A third group, the *Polynesians,* may have migrated eastward from Asia in prehistoric times. Over many centuries, most of the islands became settled. But large expanses of ocean separated the people in one part of the Pacific from those in another. As a result, people in distant island groups had little or no contact with one another.

During the 1700's and 1800's, European explorers visited most of the Pacific Islands. They noted that people in Melanesia, Micronesia, and Polynesia differed from one another in appearance. The islanders also had different languages, religions, and customs.

Some scientists divide the people of the Pacific Islands into three main groups—Melanesian, Micronesian, and Polynesian. However, other scientists suggest that there are only two basic divisions of the islanders—Melanesian and Micronesian/Polynesian.

The population groups are not clearly divided among the three geographical and cultural areas of the Pacific Islands. For example, groups of people with Polynesian features live in parts of New Guinea, which is deep in Melanesia. Furthermore, people from each of the areas have migrated to the other regions. Asians and Europeans have also moved to the islands and married islanders. Their children have mixed physical features. Nevertheless, there are still noticeable physical differences among the people in the three areas.

**Melanesians** are the shortest of the peoples of the Pacific Islands. Many resemble black Africans. In addition to their dark skin, most have black, woolly hair. Some Melanesians, called *Negritos,* are like the Pygmies (see **Negritos; Pygmies**).

**Micronesians** are somewhat taller and have somewhat lighter skin than Melanesians. Most Micronesians have wavy or woolly hair. Those who live closest to Asia have certain Asian characteristics, such as high cheekbones and straight hair. The people of the Yap Islands and some of the people of the Palau Islands are quite dark and look like Melanesians.

**Polynesians** are the tallest and have the lightest skin of the Pacific peoples. They have straight to wavy hair. Some Polynesians—especially those of the island groups of Samoa, Tonga, and Hawaii—are robust, large-boned people. Marriages between islanders and Asian or European settlers have been more common in Polynesia than in the other two cultural areas. As a result, many Polynesians have mixed Asian, European, and Polynesian physical traits.

**Other peoples** make up only a small part of the total population of the Pacific Islands. Only Hawaii and New Zealand have a majority of people who are not native to the islands. During the late 1800's, European landowners in Fiji brought thousands of people from India to work as labourers on the islands' cotton and sugar plantations. This is why many Fijians are of Indian descent.

Hawaii has many American and Japanese settlers. Most New Zealanders are descendants of settlers from Great Britain.

Smaller groups of Asians and Europeans live in other parts of the Pacific Islands. More than a third of the people of New Caledonia are of European or part-European descent. Tahiti and some other islands in French Polynesia have a number of French and Chinese settlers. Smaller numbers of Europeans and Chinese live in Fiji and New Guinea. Wherever they have settled, Americans, Asians, and Europeans have had great influence on the lives of the native islanders. Some island leaders feel that these outside influences have been too great and that the islanders have given up too many of their own traditions and customs.

**Languages.** About 1,200 of the world's 3,000 languages are spoken in the Pacific Islands. The languages are divided into two main groups: *Malayo-Polynesian* (also called *Austronesian*) and *Papuan* (also called *non-Austronesian*). Melanesia has the greatest number of languages. More than 740 languages are spoken in Papua New Guinea alone. Micronesia has about 13 major languages. Polynesia has about 20 languages, all of which are closely related.

English is the most widely used language in the Pacific Islands. It is the official language of Hawaii and of several independent countries, including Fiji, New Zealand, Tonga, and Western Samoa. English is also the official language of island territories controlled by Australia, Great Britain, New Zealand, and the United States. But many of the people of these territories speak only their native language.

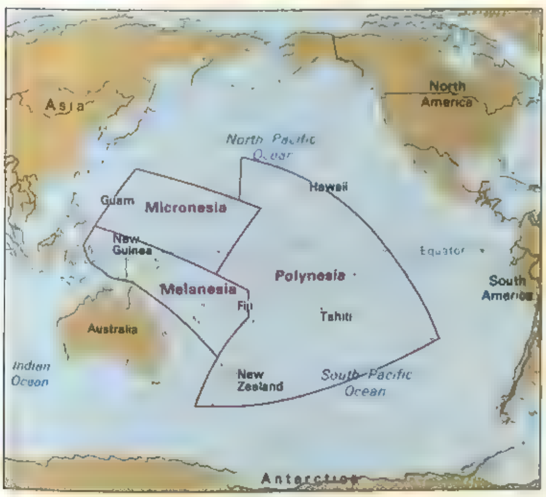
Some people who live on islands of western Micronesia speak Japanese, which they learned when Japan controlled the islands from 1920 to 1945. French is the official language of the territories controlled by France, but the islanders speak their own languages in addition to French.

A language called *Pidgin English* or *Neo-Melanesian* has developed on all the main islands of Melanesia except Fiji and New Caledonia. Pidgin English consists mainly of words from English and the native languages. This language gives the people of Melanesia, who speak many languages, a means of communicating with one another.

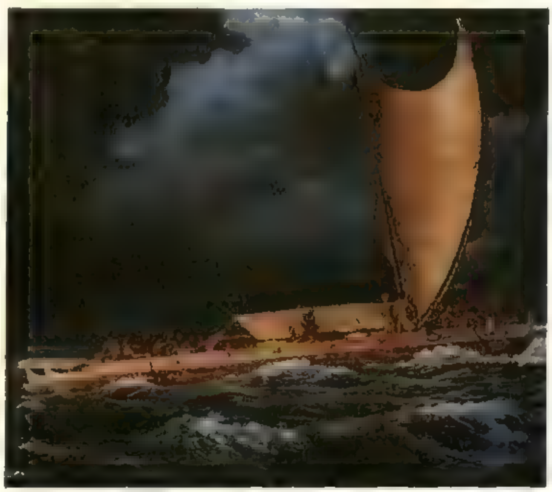
**Religions.** Christianity has been the main religion in Oceania since the late 1800's. Before then, the islands had a number of religions, all based on a belief in numerous gods or spirits. Most religions had a complicated mythology made up of stories about the creation of the earth and the relationships between the gods and people (see **Mythology** [Mythology of the Pacific Islands]).

Today, native religions survive mainly in Melanesia, particularly in New Guinea, the Solomon Islands, and Vanuatu. But even in areas where most of the people are Christians, many of the islanders still believe in magic and witchcraft. A kind of religion called a *cargo cult* exists in parts of Melanesia. Members of a cargo cult believe that the gods intend them to have a share of the goods that Westerners enjoy. The cargo cult's leaders promise that one day a giant cargo ship or plane will arrive containing the islanders' share of Western goods.

In a few parts of the Pacific Islands, the people once practised *cannibalism* (the eating of human flesh). Some people considered it a religious ceremony. They believed that by eating a dead person's flesh, they took on that person's good qualities. Cannibalism no longer exists in the Pacific Islands except in New Guinea, where it occasionally occurs.




**The Pacific Islands** can be divided into three main areas: (1) Melanesia, meaning *black islands;* (2) Micronesia, meaning *small islands;* and (3) Polynesia, meaning *many islands.* This grouping is based on the race and culture of the native peoples and on the islands' geography.



*The Great Seafarers,* a 1951 oil painting on plywood by Paul Rockwood. Hawaii Volcanoes National Park, U.S.A.

**Polynesians** from various Pacific Islands were the first people to inhabit the Hawaiian islands. They reached Hawaii in large double dugout canoes some 2,000 years ago. Later, in about A.D. 1200, Polynesians arriving from the island of Tahiti gained control of the islands.

## *Ways of life*

**Traditional ways of life** are followed by many Pacific Islanders, especially villagers who earn little or no money. At this village market in New Guinea, many of the people trade one kind of farm product for another, just as their ancestors did.

Most Pacific islanders live in small farming or fishing villages. Many of them live in the same kinds of houses, eat the same kinds of food, and wear the same kinds of clothing their ancestors did. But these traditional ways of life are changing rapidly as more and more people adopt the customs of Western countries.

**Villages.** Many Pacific islanders have left their villages to work in the towns and cities, but the village remains the basic community of the islands. The smallest villages have only a few people, and the largest have several hundred. All the families of a village feel strong ties to one another even though they may not be related. Such *kinship groups* play an important part in the lives of most Pacific islanders. In Polynesia, the people of some entire islands and groups of islands feel bound by ties of kinship.

In most villages, each family has its own house or cluster of houses. A household may include grandparents, aunts, uncles, and cousins. Most houses have a wooden framework, with walls and roof made of thatch. They have a round, oval, square, or oblong shape. In the hot coastal areas of New Guinea, many people build their homes on stilts, which makes the houses cooler and protects them from moisture on the ground. In the cool highlands of New Guinea, most of the houses are low and circular, with tightly fitted walls of wood and thatch to help conserve heat on chilly nights.

Chiefs play an important part in the affairs of many villages. A village chief is expected to advise and lead the people, show hospitality to visitors, and uphold the good name of the community. On most Pacific Islands, the chief inherits the office. In Polynesia and on Fiji, the office of chief passes from father to son. In most parts of Micronesia, a chief is succeeded by the oldest son of the chief's oldest sister. In Melanesia, a village chief earns the office by achievement rather than by birth.

**Towns and cities.** Oceania has few towns and cities, but they are growing rapidly. Hawaii and New Zealand have the only large cities in the islands. The largest city outside Hawaii and New Zealand is Port Moresby, Papua New Guinea, which has more than 120,000 people. Other small cities or large towns include Apia in Western Samoa, Nouméa in New Caledonia, Papeete in French Polynesia, and Suva in Fiji. Most towns and cities in Oceania have an elected governing body.

Houses in Pacific Island towns and cities look much like those in Western countries and are made of such materials as wood, concrete block, and brick. The rapid growth of towns and cities has created a housing shortage in some areas. As a result, shantytowns have sprung up on the outskirts of the fastest-growing towns. Some island governments have started programmes to build modern, inexpensive houses.

**Food.** Traditionally, the people of the Pacific Islands have depended largely on fish and native plants for food. In shallow water, people catch crabs, lobsters, shrimps, and turtles. Farther out at sea, they catch bonito and tuna. On many islands, the people eat the fruit of breadfruit and pandanus trees and the meat of coconuts from the coconut palm. The people of New Guinea make flour from the starchy *pith* (soft centre) of the sago palm. They use the flour to make small cakes and biscuits. Many islanders have vegetable gardens in which they grow sweet potatoes and *taro,* a plant with a starchy root. Many people also raise bananas and some plants introduced from other parts of the world, such as maize, pineapples, rice, and tomatoes. Some farmers also have chickens and pigs.

**Ceremonial dances** are a colourful tradition of the islands. These New Guinea dancers are taking part in a ceremony called a *sing-sing.*

**New ways of life** have come mainly from the West. These Fiji islanders are playing Rugby football, a British game. Many Pacific islanders—especially in the towns and cities—have given up their native customs and adopted Western ways.

Many islanders cook their food in ground ovens. A common type of ground oven consists of a shallow pit lined with heated stones. The food is placed on the stones and covered with a layer of leaves. The pit is then filled with earth to hold in the heat.

Although many islanders still eat the traditional foods, canned foods from Western countries have become so popular on some islands that many people eat almost nothing else. As a result, malnutrition is a problem in many cities and towns. Local health agencies try to persuade the people to balance their diets with fresh fruit, vegetables, and meat.

**Clothing.** Many people in the Pacific Islands, especially in the towns and cities, wear Western-style clothing. But some villagers wear traditional dress. In Polynesia and Fiji, the men often wear a cloth skirt called a *lava-lava,* or *sulu.* Some women in Fiji, Hawaii, and Samoa wear long, loose-fitting cotton garments called *muumuus.* In Fiji, Samoa, and Tonga, women also make skirts of *tapa cloth.* They make tapa cloth by stripping the inner bark from paper mulberry trees, soaking it, and then beating it with wooden clubs. On a number of islands—especially the Gilbert Islands, New Guinea, and the Solomon Islands—both men and women sometimes wear grass skirts. A few mountain tribes in New Guinea, the Solomons, and Vanuatu wear only brief coverings of bark or leaves around their waists. In the cool New Guinea highlands, some of the people keep warm by greasing their naked bodies with pig fat.

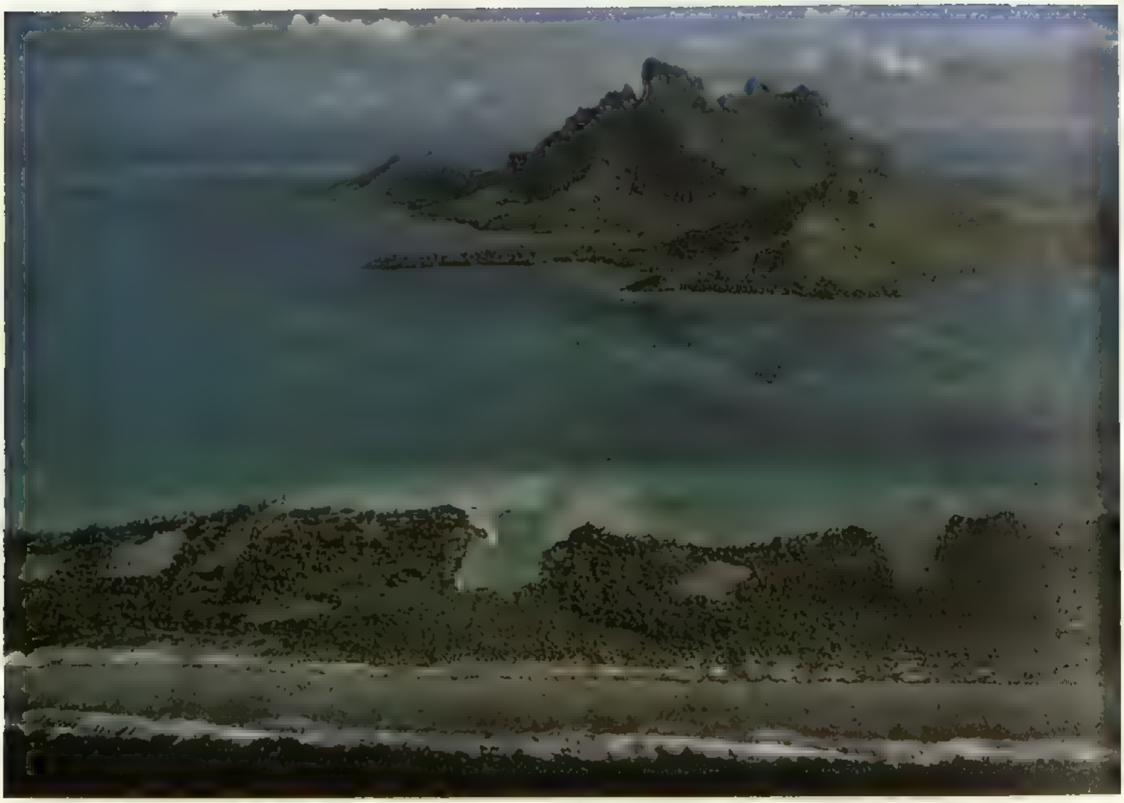
**Arts and crafts.** Many islanders, especially in the villages, are skilled artists and craftworkers. On some islands, the people use the leaves and fibres of native plants, such as palm and pandanus trees, to weave baskets and mats, which they decorate with colourful designs. Some islanders use native woods to carve masks, cooking utensils, and other objects. On a few islands, people make pottery. The islanders sell some of their handicrafts to tourists and export companies. See **Sculpture** (Pacific Islands) for a description and pictures of the colourful sculpture of the Pacific area.

**Recreation.** On most islands of the Pacific, the villagers gather for traditional feasting, dancing, and singing on such occasions as births and marriages. Dancing is an important part of village festivities. The dancers often wear masks, feathers, flowers, sea shells, or other colourful ornaments. Polynesian dancing is especially lively. The Tahitian *tamure* and the Hawaiian *hula* are popular Polynesian dances. On some Polynesian islands and on Fiji, important festivals include the ceremonial drinking of *kava,* a drink made from the roots of the native kava plant. Many islanders enjoy playing games introduced from Western countries, such as volleyball and Rugby football.

**Education.** All the populated islands of Oceania have primary schools, and many also have secondary schools. Christian missionaries started the first schools in the Pacific and continue to operate many of them today. Most islands could not afford to run schools without the missionaries' help. But some island governments are able to assist the mission schools financially.

Many island children do not continue their education beyond primary school. Relatively few young people finish secondary school and go on to college or university. Hawaii and New Zealand have the only large universities in the Pacific Islands. Smaller universities are located in Fiji, Guam, and Papua New Guinea. Some islands have small colleges that specialize in agriculture, medicine, or theology.

# Land and climate



**Two main types of islands** are found in the Pacific. *High islands* are mountainous and volcanic. *Low,* or *coral, islands* are formed by skeletons of tiny sea animals. The island in the background—Bora Bora—is a high island surrounded by small coral islands like the one in the foreground.

The islands of the Pacific can be divided into two main types: (1) high islands and (2) low islands.

**The high islands** are made up largely of hills and rugged mountains. Some of the mountains rise high above sea level, and many are active volcanoes. The high islands also have frequent, sometimes severe, earthquakes. The largest islands of the Pacific—New Britain, New Caledonia, New Guinea, and New Zealand—are high islands. The high islands also include the main islands of such groups as Fiji, Hawaii, the Marianas, Samoa, the Solomons, and Vanuatu.

**The low islands** consist of *coral reefs,* which are formed by the skeletons of millions of tiny sea animals (see **Coral**). Thousands of these islands are scattered throughout the Pacific. Most of them are smaller than the high islands and rise only a metre or so above sea level. Earthquakes in the Pacific sometimes produce gigantic ocean waves that flood the lowest of these islands.

The majority of the low islands are *atolls.* An atoll is a coral reef—or a number of small reefs called *motus*—surrounding a large lagoon. The low islands include all the islands in the Gilbert, Marshall, Phoenix, Tuamotu, and Tuvalu groups, as well as many individual islands in other groups. Movements within the earth have lifted some atolls higher than others. Such *raised atolls* include Nauru and Niue. Coral reefs or atolls also lie off the shores of most high islands.

**Climate.** Almost all the islands of the Pacific lie in the tropics and so are warm all year round. On most islands, the temperature seldom falls below about 20° C or rises above about 27° C. But mountainous areas in New Guinea and a few other high islands are somewhat cooler. The highest mountains in New Guinea and New Zealand are snow covered throughout the year.

Rainfall varies greatly throughout Oceania. Some islands, especially the low islands, may have only a few centimetres of rain a year. Other islands, especially the Carolines and the high islands in western Melanesia, often have more than 380 centimetres a year. Most islands have a wet season and a dry season. In Melanesia and Polynesia, the wet season lasts from December to March and the dry season from April to November. In Micronesia, the wet season lasts from May to December and the dry season from January to April.

Typhoons often strike islands in the Pacific. They bring violent winds and heavy rains, which sometimes cause great loss of life and considerable damage to property. In Micronesia, typhoons may strike at any time, but they occur most frequently from July to October. Most typhoons in the South Pacific occur from January to March.

## Independent countries of Oceania*

| Name | Area in km² | Population | Capital | Official language | Date of independence |
|---|---|---|---|---|---|
| **Fiji** | 18,274 | 769,000 | Suva | English | 1970 |
| **Kiribati** | 726 | 81,000 | Tarawa | English | 1979 |
| **Marshall Islands** | 181 | 57,000 | Majuro | Marshallese; English | 1986 |
| **Micronesia, Federated States of** | 702 | 126,000 | Palikir | English | 1986 |
| **Nauru** | 21 | 11,000 | — | Nauruan | 1968 |
| **New Zealand** | 270,534 | 3,583,000 | Wellington | English | 1907 |
| **Palau, Republic of** | 459 | 17,000 | Koror | Palauan; English | 1994 |
| **Papua New Guinea** | 462,840 | 4,443,000 | Port Moresby | Melanesian pidgin English; Motu | 1975 |
| **Solomon Islands** | 28,896 | 390,000 | Honiara | English | 1978 |
| **Tonga** | 747 | 100,000 | Nukualofa | English; Tongan | 1970 |
| **Tuvalu** | 26 | 13,000 | Funafuti | Tuvaluan; English | 1978 |
| **Vanuatu** | 12,189 | 173,000 | Port-Vila | Bislama; English; French | 1980 |
| **Western Samoa** | 2,831 | 160,000 | Apia | Samoan; English | 1962 |

*Each country listed has a separate article in *World Book*.

## Other political units in Oceania

| Name | Area in km² | Population | Status |
|---|---|---|---|
| **American Samoa†** | 199 | 48,000 | U.S. territory |
| **Cook Islands†** | 240 | 17,000 | Self-governing area in free association with New Zealand |
| **Easter Island†** | 122 | 2,000 | Chilean dependency |
| **French Polynesia†** | 4,000 | 203,000 | French overseas territory |
| **Guam†** | 541 | 133,000 | U.S. territory |
| **Hawaii†** | 16,729 | 1,115,000 | U.S. state |
| **Irian Jaya** | 421,981 | 1,556,000 | Indonesian province |
| **Midway Island†** | 5 | 450 | U.S. possession |
| **New Caledonia†** | 19,079 | 165,000 | French overseas territory |
| **Niue†** | 260 | 3,000 | Self-governing area in free association with New Zealand |
| **Norfolk Island†** | 36 | 2,000 | Australian territory |
| **Northern Mariana Islands, Commonwealth of the†** | 477 | 43,000 | U.S. commonwealth |
| **Pitcairn Islands†** | 5 | 60 | British dependency |
| **Tokelau†** | 10 | 2,000 | New Zealand territory |
| **Wake Island†** | 8 | 300 | U.S. possession |
| **Wallis and Futuna Islands** | 275 | 14,000 | French overseas territory |

Populations are 1996 estimates for independent countries. The figures for dependent countries are 1995 or earlier estimates.
†Has a separate article in *World Book*.


## Pacific Islands map index

### Political units

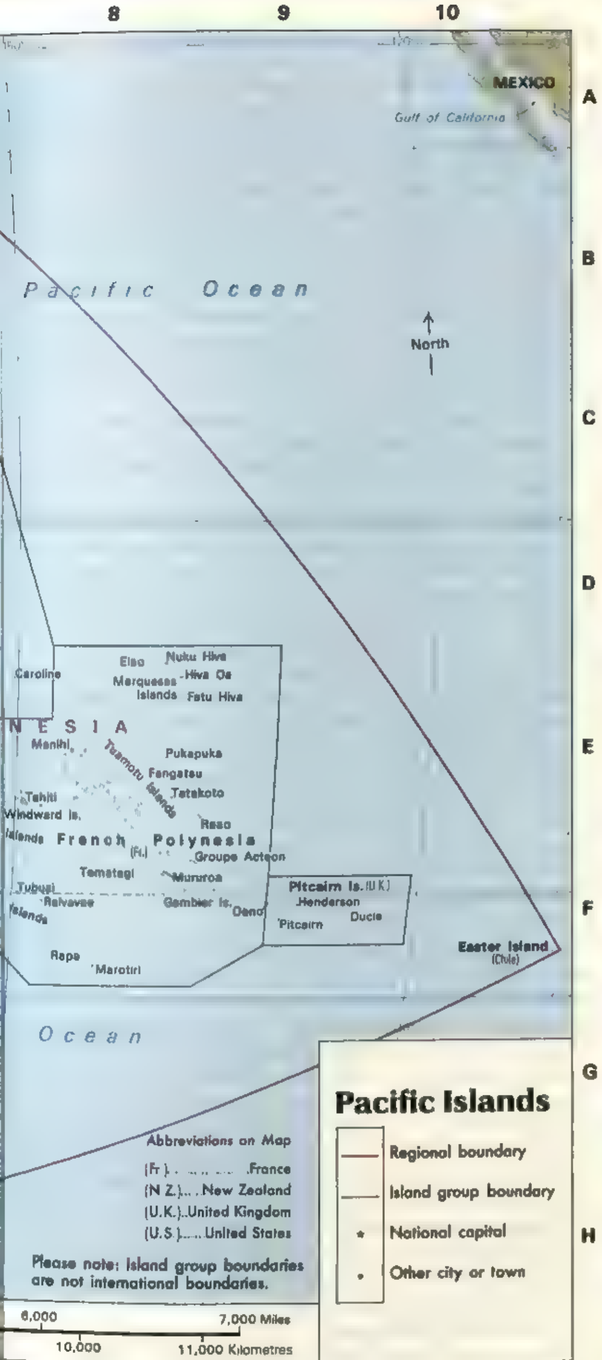
| | | |
|---|---|---|
| American Samoa | E | 6 |
| Cook Islands | E | 6 |
| Easter Island | F | 10 |
| Fiji | F | 5 |
| French Polynesia | F | 8 |
| Guam | B | 2 |
| Hawaii | B | 7 |
| Irian Jaya | D | 1 |
| Kiribati | D | 6 |
| Marshall Islands | C | 4 |
| Micronesia, Federated States of | C | 3 |
| Midway Island | A | 5 |
| Nauru | D | 4 |
| New Caledonia | F | 3 |
| New Zealand | H | 4 |
| Niue | E | 6 |
| Norfolk Island | F | 4 |
| Northern Mariana Islands, Commonwealth of the | B | 2 |
| Palau, Republic of | C | 1 |
| Papua New Guinea | D | 2 |
| Pitcairn Islands Group | F | 9 |
| Solomon Islands | D | 4 |
| Tokelau Islands | D | 6 |
| Tonga | E | 6 |
| Tuvalu | D | 4 |
| Vanuatu | E | 4 |
| Wake Island | B | 4 |
| Wallis and Futuna Islands | E | 5 |
| Western Samoa | E | 5 |

### Island groups

| | | |
|---|---|---|
| Admiralty Islands | D | 2 |
| Austral Islands | F | 7 |
| Bismarck Archipelago | D | 2 |
| Caroline Islands | C | 2 |
| D'Entrecasteaux Islands | E | 2 |
| Gambier Islands | F | 8 |
| Gilbert Islands | C | 4 |
| Groupe Acteon | F | 9 |
| Haapai Group | F | 6 |
| Lau Group | E | 5 |
| Leeward Islands | E | 7 |
| Line Islands | D | 7 |
| Louisiade Archipelago | E | 3 |
| Loyalty Islands | F | 4 |
| Marquesas Islands | E | 8 |
| Mortlock Islands | C | 2 |
| Palau Islands | C | 1 |
| Ralik Chain | C | 4 |
| Ratak Chain | C | 4 |
| Santa Cruz Islands | E | 4 |
| Society Islands | E | 7 |
| Tongatapu Group | F | 5 |
| Trobriand Islands | D | 2 |
| Truk Islands | C | 3 |
| Tuamotu Islands | E | 8 |
| Windward Islands | E | 8 |

### Individual islands

| | | |
|---|---|---|
| Agrihan | B | 2 |
| Anatahan | B | 2 |
| Banaba | D | 4 |
| Bikini | B | 4 |
| Bora Bora | E | 7 |
| Bougainville | D | 3 |
| Enewetak | B | 3 |
| Espiritu Santo | E | 4 |
| Gardner | A | 6 |
| Guadalcanal | E | 3 |




| | | | | | |
|---|---|---|---|---|---|
| Hawaii | B | 7 | Palmyra | C | 7 |
| Helen | C | 1 | Pentecost | E | 4 |
| Henderson | F | 9 | Pitcairn | F | 9 |
| Jaluit | C | 4 | Rarotonga | F | 6 |
| Johnston | B | 6 | Rota | B | 2 |
| Kauai | A | 7 | Saipan | B | 2 |
| Kure | A | 5 | Tahiti | E | 8 |
| Kwajalein | C | 4 | Taongi | B | 4 |
| Laysan | A | 6 | Tinian | B | 2 |
| Lisianski | A | 5 | Tutuila | E | 6 |
| Maui | B | 7 | Upolu | E | 6 |
| Mili | C | 4 | | | |
| Necker | A | 6 | | | |
| Nihoa | A | 6 | | | |
| Oahu | B | 7 | | | |
| Pagan | B | 2 | | | |

**Kilauea, on the Island of Hawaii,** is one of the most spectacular volcanoes in the Pacific Islands. On the same island is Mauna Loa, the world's largest volcano.

**Black sand** is a feature of some beaches in Hawaii and other Pacific Islands. It is formed from solidified volcanic lava.

## Economy

**Producing copra,** the dried meat of the coconut, is a main economic activity in many of the Pacific Islands. This Samoan worker is removing the meat from the coconut shell before drying.

Hawaii, New Zealand, and Nauru have well-developed economies. Hawaii's economy is based largely on U.S. government employment and on tourism. New Zealand has thriving agricultural and manufacturing industries. On these islands, most workers are wage earners. The people of Nauru receive most of their income from mining operations. But on the other Pacific Islands, many people earn little or no money. Most of them are villagers who grow their own food, build their own houses, and make their own clothing. They may earn a small income by growing coconuts, bananas, or sugar cane to sell to export companies. Throughout the Pacific Islands, a growing number of villagers are moving to the towns and cities to work for wages.

**Natural resources.** On many of the low islands, the soil is too poor and the rainfall too light for plants to grow well. Only grass and small shrubs grow on these islands. Low islands with heavier rainfall have coconut palms and pandanus trees. Many of the high islands have fairly fertile soil and plentiful rainfall. Unusual flowers and trees grow on these islands. New Guinea, the Solomon Islands, and Vanuatu are covered with thick jungles and steaming forests.

The islands' few native animals include birds, land crabs, lizards, and rats. Albatrosses, terns, and other birds are by far the most common animals. New Guinea and a few nearby islands have crocodiles and snakes. These islands also have cuscuses, kangaroos, and other *marsupials* (mammals that give birth to extremely undeveloped young).

The islands have few mineral resources, except for valuable deposits of nickel on the island of New Caledonia and copper, gold and oil on New Guinea. New Caledonia also has some chromium and iron, and Fiji has small deposits of gold and manganese. Nauru has deposits of *phosphate,* a chemical compound that is used to make fertilizer.

**Agriculture** is the main industry of Oceania, and *copra* (the dried meat of the coconut) is the most important agricultural product. Factories crush copra to produce coconut oil, which is used to make such products as margarine and soap. Countries in many parts of the world import coconut oil or copra from the Pacific Islands. Tonga, Western Samoa, Fiji, and the Cook Islands also grow bananas for export. The production and export of sugar is the main industry in Fiji. New Guinea farmers grow cocoa and coffee for sale overseas. At one time, Europeans owned much of the farmland in the Pacific Islands. Today, many islanders have their own farms. In some villages, the farmland belongs to the entire community.

**Mining and manufacturing.** Many of the islands are trying to develop other industries in addition to agriculture. Islands with mineral deposits, such as Fiji and New Caledonia, are expanding their mining industries. On Bougainville in Papua New Guinea, American, Australian, British, and other banking interests are helping develop one of the world's largest copper mines. This mine also contains valuable deposits of gold. Phosphate mining is important on Nauru, but phosphate deposits are being used up rapidly. When the supplies are exhausted, the people will then have to find other ways to support themselves. In the larger towns of the Pacific Islands, mills and factories produce such goods as coconut oil, soap, and sugar. The Solomon Islands, Papua New Guinea, Western Samoa, and some other forested islands have sawmills that are used to process native timbers.

**The tourist industry** in the Pacific Islands has grown tremendously since the beginning of jet aeroplane travel in the 1950's. As more and more tourists come to the islands, more airports, hotels, roads, shops, and restaurants will have to be built. Islands that actively encourage tourism, such as the Cook Islands, Fiji, and Tahiti, are developing these facilities. But some islanders fear that further growth of the tourist industry will destroy the natural charm and traditional way of life of the Pacific Islands. In some island groups, attempts have been made to control the development of tourism.

**Transportation.** Canoes have long been the traditional means of transportation throughout the Pacific Islands. Villagers use them for fishing and for travelling short distances. To make longer voyages, they use canoes equipped with sails or outboard motors.

Many islanders depend on ships and aeroplanes for transportation. Ships of all sizes connect the major ports, and aeroplanes deliver food and other supplies to the islands. Fiji, New Guinea, and some other islands have their own commercial airlines, which carry both passengers and cargo.

None of the islands has a well-developed network of roads. But in the cities and large towns, many people own cars, and traffic jams occur during rush hours just as they do in Western cities.

**The first settlers.** Most scholars believe the first settlers in the Pacific Islands came from Southeast Asia thousands of years ago. They probably reached the Pacific by way of Indonesia and then travelled to islands in Melanesia. They followed land bridges where possible and made other parts of their journey by water, using rafts or dugout canoes. Some may have sailed northward to Micronesia. Over hundreds of years, settlements were set up in Melanesia and Micronesia.

Most of the islands of Polynesia were settled later than those of Melanesia and Micronesia. Many Polynesian islands are farther apart than islands in Melanesia and Micronesia and so are harder to reach by boat. The first settlers of Polynesia were probably groups of seafaring people from eastern Melanesia or Micronesia. Some of these groups may have set out in search of new homes. Other groups may have been blown off course by violent storms. But in time, groups such as these established settlements on all the main Polynesian islands.

**Discovery by Europeans.** In 1513, the Spanish explorer Vasco Núñez de Balboa became the first European to sight the eastern Pacific. He saw it from Panama. In 1520, the Portuguese explorer Ferdinand Magellan began to sail westward across the Pacific. In 1521, he discovered Guam. Following Magellan's discovery, many Europeans searched the Pacific for other islands. The Caroline, Marquesas, Solomon, and Tuvalu island groups were discovered during this period. A Dutch explorer, Abel Janszoon Tasman, discovered New Zealand in 1642. The greatest Pacific explorer of the 1700's was Captain James Cook of the British Royal Navy. Between 1768 and 1779, he discovered Hawaii, New Caledonia, and other islands.

**Missionaries, traders, and settlers.** Cook's discoveries encouraged Protestants and Roman Catholics to establish missions throughout Oceania. As a result, many islanders became Christians during the 1800's. Many missionaries introduced genuine improvements to the islands, but others concentrated largely on doing away with native customs and traditions. At the same time, European and American traders searched the Pacific for coconut oil, sandalwood, and other products. Ships from many countries came to hunt whales. Some traders and whalers treated the islanders badly and were badly treated in return. Slave traders called *blackbirders* took shiploads of islanders to work on plantations in Australia and South America.

European settlers also began to arrive in the islands. Wealthy Europeans started coconut, coffee, pineapple, and sugar plantations. But the new settlers also included many criminals and drifters, and lawlessness became a problem. Europeans also brought diseases against which the islanders had no resistance. On some islands, epidemics wiped out most of the original population.

**Colonial rule.** By the late 1800's, France, Germany, Britain, Spain, and the United States were competing for control of islands in the Pacific. After Spain's defeat in the Spanish-American War of 1898, Germany and the United States took over the Spanish possessions in Micronesia. By the early 1900's, Germany also held parts of Nauru, New Guinea, and Samoa, and the United States controlled Hawaii and the rest of Samoa. France controlled New Caledonia and French Polynesia and shared control of the New Hebrides (now Vanuatu) with Britain. Britain held Fiji, Papua, Tonga, the southern Solomons, and the Gilbert and Ellice islands. By 1910, Australia and New Zealand had won independence from Britain. After Germany's defeat in World War I (1914-1918), Japan received control of the German possessions in Micronesia, New Zealand took over German Samoa, and Australia received control of northeastern New Guinea. Through all these changes of rule, the islanders had little or no voice in the government.

**World War II (1939-1945).** Japan increased its power in the Pacific after World War I. In December 1941, Japanese bombers attacked the U.S. naval base at Pearl Harbor, Hawaii, marking the beginning of World War II in the Pacific. By mid-1942, Japanese troops had captured islands as far east as the Gilberts and as far south as the Solomons. The United States and its allies then began the difficult job of driving the Japanese off these islands. Bloody battles were fought at Tarawa and on Guadalcanal, Iwo Jima, and other islands. In September 1945, Japan surrendered, and lost its huge Pacific empire.

**Atomic testing.** After World War II, the United States began nuclear bomb tests on Bikini and Enewetak atolls in Micronesia and on Kiritimati Atoll (Christmas Island) and Johnston Island in Polynesia. Britain conducted similar tests on Kiritimati Atoll. In 1963, the two countries and the Soviet Union signed a treaty banning above-ground nuclear tests. The United States and Britain then stopped their tests in the Pacific. France also has nuclear weapons but did not sign the test-ban treaty. In 1965, it began nuclear testing in the Tuamotu Islands.

**Recent developments.** An organization called the South Pacific Commission has helped promote the economic and social welfare of the islands. The commission was founded in 1947 by Australia, Britain, France, the Netherlands, New Zealand, and the United States. The Netherlands withdrew in 1962, after Indonesia took control of Dutch (West) New Guinea. Today, the commission includes most of the islands. But the newly independent countries have complained that the commission is dominated by its more powerful members. As a result, the Cook Islands, Fiji, Nauru, Tonga, and Western Samoa organized the South Pacific Forum in 1971 to promote cooperation among themselves in such matters as international relations and trade. Australia and New Zealand were included as Forum members because of their location and their involvement in the affairs of the region. As other islands gain self-government, they have been invited to join the Forum. Forum members hope that by cooperating with one another they will become less dependent on Western nations.

Since 1962, several Pacific islands or island groups have become independent, and others have been working toward this goal. Britain granted full independence to Fiji and Tonga in 1970 and to the southern Solomon Islands and to Tuvalu (formerly the Ellice Islands) in 1978. In 1979, Britain's Gilbert Islands dependency became the independent nation of Kiribati. In 1980, the New Hebrides—which had been ruled jointly by Britain and France—became the independent nation of Vanuatu.

After World War II, the United Nations (UN) decided that four areas in the Pacific should be governed as trust territories until they were ready for independence. New Zealand administered Western Samoa as a trust territory until 1962, when Western Samoa gained independence. Australia, Britain, and New Zealand governed Nauru as a trust territory until 1968, when it became independent. The Trust Territory of New Guinea was governed by Australia until 1973, when it became part of the self-governing territory of Papua New Guinea. Papua New Guinea gained full independence in 1975.

In 1965, the Cook Islands—a New Zealand territory—gained a form of self-government. The islands control internal affairs, and New Zealand handles external affairs as requested. Another New Zealand territory, the island of Niue, gained self-government in 1974.

The United States administered the Trust Territory of the Pacific Islands, which was divided into four political units. In 1986, all of the Mariana Islands except Guam became a commonwealth of the United States. Guam is a U.S. territory. Also in 1986, the Marshall Islands and the Federated States of Micronesia—comprising all of the Caroline Islands except the Palau group—became independent nations in free association with the United States. Under free association, these governments control all internal and foreign affairs, but the United States is obligated to defend the islands in emergencies. In October 1994, Palau became an independent nation in free association with the United States. The Republic of Palau joined the United Nations on Dec. 15, 1994.

**Related articles.** For a list of *World Book* articles on the islands of the Pacific, see the *Related articles* at the end of the Island article. See also the following:

| | | |
|---|---|---|
| Atoll | Mana | Sculpture (Pacific Islands) |
| Coconut palm | Mythology (Mythology of the Pacific Islands) | Tapa |
| Copra | | Volcano |
| Coral | Pacific Ocean | World War II (The war in Asia and the Pacific) |
| [illegible] | Races, human | |
| [illegible] | | |
| [illegible] | | |

### Outline

**I. Peoples**
- A. Melanesians
- B. Micronesians
- C. Polynesians
- D. Other peoples
- E. Languages
- F. Religions

**II. Ways of life**
- A. Villages
- B. Towns and cities
- C. Food
- D. Clothing
- E. Arts and crafts
- F. Recreation
- G. Education

**III. Land and climate**
- A. The high islands
- B. The low islands
- C. Climate

**IV. Economy**
- A. Service industries
- B. Agriculture
- C. Mining and manufacturing
- D. The tourist industry
- E. Transportation

**V. History**

### Questions

What is the main industry in the Pacific Islands?
What is another name for the Pacific Islands?
Where did the first Pacific islanders come from?
What is a coral atoll? An atoll?
What are the duties of a village chief?
Why do some islanders fear the further growth of tourism in the Pacific?
What is kava? A mountain? A cargo cult?
What are the islanders' two main ways of life?
What are the three main areas in Oceania?

**Pacific Islands, Trust Territory of the.** See Caroline Islands; Mariana Islands; Marshall Islands; Palau Islands.

**Pacific Ocean** is the largest body of water in the world. The Pacific Ocean represents half of the world's ocean area and more than a third of the surface area of the earth. The Pacific stretches from the Bering Strait in the north to Antarctica in the south. It is bordered by North and South America in the east and by Asia and Australia in the west. A number of seas, called *marginal seas*, are also considered part of the Pacific Ocean.

The word *pacific* means peaceful. The ocean received this name from the Portuguese explorer Ferdinand Magellan, who sailed its waters for weeks, driven by gentle winds. But the Pacific is not always peaceful. Its typhoons and hurricanes have wrecked fleets of ships and destroyed island cities. Earthquakes and volcanic eruptions deep in the sea have caused huge destructive waves called *tsunamis*.

**Boundaries and size.** North and South America form the eastern boundary of the Pacific Ocean. The Asian continent, the Sunda Islands of Indonesia, and Australia lie to the west. The Bering Strait connects the Pacific Ocean with the Arctic Ocean in the north. Some geographers mark the southern boundary of the Pacific at about 50° south latitude. There, they say, the Antarctic or Southern Ocean begins.

However, most geographers do not officially recognize the existence of an Antarctic Ocean. They regard the Pacific as extending to the coast of Antarctica, the continent that surrounds and covers the South Pole.

Geographers divide the Pacific at the equator into the North Pacific and the South Pacific. The Pacific and its marginal seas cover about [illegible] million square kilometers. The ocean is about [illegible] kilometers long from the Bering Strait to Cape Adare, Antarctica. It is widest near the equator between Panama and the Malay Peninsula. There, it measures about [illegible] kilometers, about three-fifths of the distance around the world.

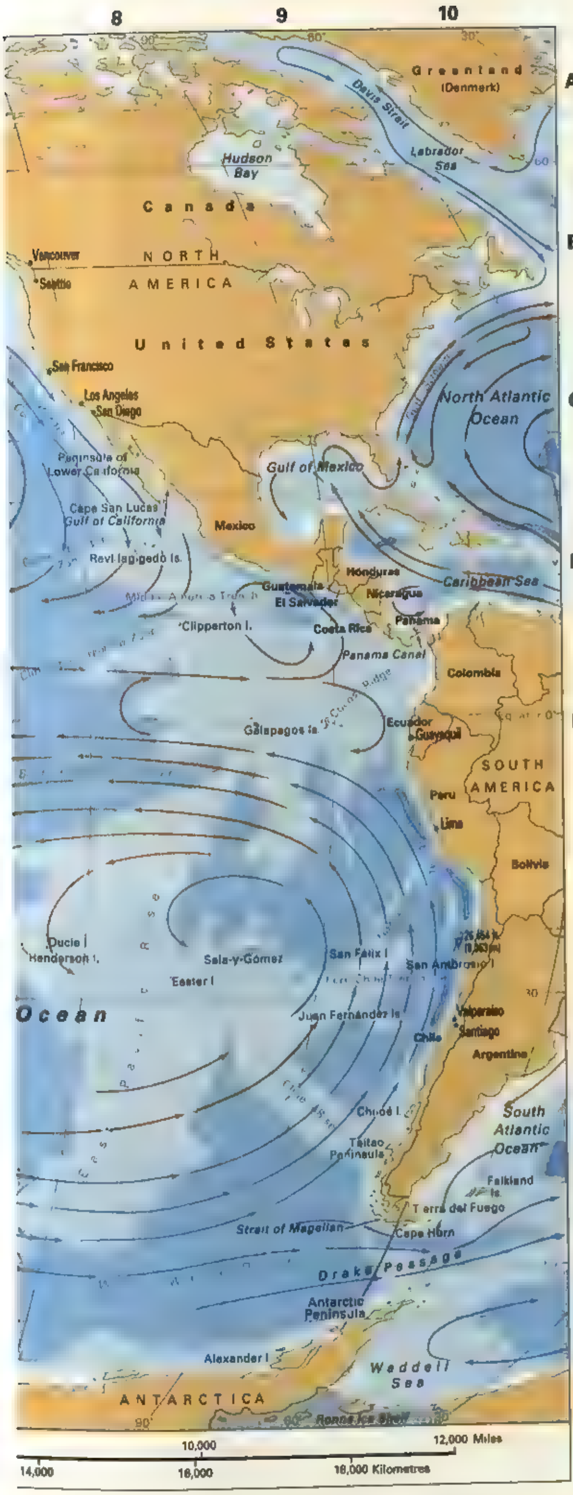
**Coastline and islands.** The Pacific coasts of North and South America are relatively even. The Gulf of California forms the only large inlet, and few islands lie offshore. The western Pacific has uneven shores, and features a number of marginal seas that are separated by large islands. The marginal seas include the Sea of Okhotsk, the Sea of Japan, the East China Sea, the South China Sea, the Java Sea, the Banda Sea, the Timor Sea, the Coral Sea, and the Tasman Sea. The Bering Sea is located north of the Aleutian Islands and south of the Bering Strait. The largest Antarctic sea is the Ross Sea.

The Pacific Ocean has thousands of islands. Some lie near the mainlands of continents and are grouped with them. Many other islands are scattered throughout the Pacific. These islands are sometimes called the *Pacific Islands* or Oceania. See **Pacific Islands**.

**The ocean floor.** The Pacific has an average depth of about [illegible] meters, but the ocean floor is extremely uneven. It includes underwater mountains and ridges and extremely deep areas called *trenches*.

A great underwater mountain range extends from south of Antarctica to North America off Mexico. This


## Pacific Ocean map index






Oceanographers aboard the British scientific ship *Challenger* became the first to study the Pacific floor. In 1874 and 1875, they obtained samples of the seabed and many deep-sea organisms. Through the years, people determined the depth of various parts of the Pacific by lowering cables to the bottom. During the 1930's, oceanographers began to measure depth with *sonar,* a detecting device based on sound. Sonar and other electronic instruments enabled mapmakers to map many features of the Pacific floor by 1970.

In 1960, Donald Walsh of the U.S. Navy and Jacques Piccard, an oceanographer from Belgium, descended 10,900 metres in the Mariana Trench aboard the *bathyscaph* (diving craft) called *Trieste.* In 1977, scientists aboard the research vessel *Alvin* discovered the first hot vent, on the Galapagos Rift. Further exploration has identified vents on the Juan de Fuca Ridge off the coast of Washington and Oregon in the United States, on the East Pacific Rise, and in the western Pacific.

**Related articles** in *World Book* include:


Atoll
Balboa, Vasco Núñez de
Bathyscaph
China Sea
Cook, James
Coral
Coral Sea
El Niño
Fishing industry
Gulf of California
Japan, Sea of
Japan Current
Magellan, Ferdinand
Ocean
Okhotsk, Sea of
Pacific Islands
Peru Current
Sonar
Tidal wave
Volcano
Yellow Sea


**Pacific Rim** is a term widely used to describe countries that border the Pacific Ocean. It also describes countries of powerful economic and political influence that do not directly border the Pacific but have a profound effect on the affairs of the region. Such countries include Brunei, China, Hong Kong, the Republic of Korea (South Korea), Malaysia, the Philippines, Singapore, Taiwan, and Thailand. Russia is geographically a Pacific Rim country, but its traditional political and economic links have been with Europe. Other countries that border the Pacific are Australia, Indonesia, Japan, New Zealand, Papua New Guinea, Canada, the United States, and those of Central and South America.

Journalists in the United States first used the term *Pacific Rim* during the late 1980's to symbolize informally the common political and economic interests of the countries fringing the Pacific Ocean. Economic and political alliances have been formed among the countries of the Pacific Rim. One of the best known of these alliances is Asia-Pacific Economic Co-operation (APEC). It was founded in 1989 at a meeting in Canberra, Australia. Its 15 member countries are Australia, Brunei, Canada, China, Hong Kong, Indonesia, Japan, Republic of Korea, Malaysia, New Zealand, Philippines, Singapore, Taiwan, Thailand, and the United States. APEC's aims are to encourage and maintain economic growth and development, and reduce barriers to trade and investment. Another alliance involving Pacific Rim countries is the Association of Southeast Asian Nations (ASEAN) (see **Association of Southeast Asian Nations**).

**Pacifism** is a belief that rejects the use of violence. Many pacifists are opposed either to certain wars or to all wars. But in its strictest sense, pacifism means opposition to all violence and is called *nonresistance.*

The word pacifism was coined by Émile Arnaud, a French statesman, in 1901 at the 10th Universal Peace Congress in Glasgow, Scotland. He was describing the

beliefs of those who urged the use of international law and diplomacy, instead of war, to settle conflicts among countries. During World War I (1914-1918), the meaning of the term shifted, especially in the United Kingdom (UK) and the United States. At that time, the word came to represent opposition to all wars, called *absolute pacifism,* or to specific wars. Pacifist groups opposed participation in World War I and supported *conscientious objectors*—individuals whose consciences do not let them take up arms during warfare (see **Conscientious objector**).

Pacifism has been associated with such major religions as Buddhism, Hinduism, and Christianity. Since the 1600's, the Quakers have been the religious group most closely associated with the belief (see **Quakers**).

During the 1920's and 1930's, between World Wars I and II, pacifists in the UK and the United States developed strong antiwar movements. Pacifists supported the organization of the United Nations after World War II ended in 1945. From the 1950's to the 1980's, European pacifists were among those who protested against nuclear weapons. In the United States, pacifists helped lead the opposition to the Vietnam War (1957-1975).

Pacifist techniques have also been used to bring about social change. Mohandas Gandhi, the leader of India's struggle for independence from the UK, organized nonviolent disobedience to British laws that he believed were unfair. Gandhi's approach became known as *nonviolent resistance* or *Satyagraha* (see **Gandhi, Mohandas K.**). In the 1950's and 1960's, American civil rights leader Martin Luther King, Jr., applied Gandhi's approach in working for equality for American blacks (see **King, Martin Luther, Jr.**). The technique is now called *nonviolent action.*

**Pack rat.** See **Wood rat.**

**Packaging** is the preparation of goods for distribution and sale in bottles, boxes, tin cans, and other containers. Packaging includes the design and testing of containers and container materials. Almost everything grown, processed, or made must be packaged for protection and identification.

Designers have developed convenient packages, such as boil-in plastic bags, pull tab cans, bubble packages, plastic squeeze bottles, and aerosol cans. *Boil-in plastic bags* contain frozen food that the consumer prepares by heating the bag in boiling water. *Pull tab cans* for beverages are made of aluminium and are opened by bending back the metal tab on the lid. *Bubble packages* hold small hardware items, cosmetics, toys, or razor blades under a see-through plastic bubble. *Plastic squeeze bottles* contain washing-up liquid, cosmetics, glue, mustard, jams, and other products. The consumer squirts out the desired amount of the product by squeezing the bottle. *Aerosol cans* hold such varied products as paints, hair sprays, whipped cream, and insecticides under high pressure. The contents are released by pushing the cap.

**Related articles** in *World Book* include:

| | |
|---|---|
| Aerosol | Glass (Glass containers) |
| Bottle | Industrial design |
| Cellophane | Paper bag |
| Consumerism (The right to information) | Plastics (How plastics are used; Plastics and the environment) |
| Food (Packaging) | Tin can |
| Food, Frozen (Packaging) | |

**Packer** is the name of two Australian publishers.

**Sir Frank Packer** (1906-1974) helped found the *Australian Women's Weekly* in 1933. He was chairman of the Australian Consolidated Press publishing company from 1957 until his death in 1974. He was also chairman of a sailing syndicate that unsuccessfully challenged for the America's Cup in 1962 and 1970. He was born in Sydney.

**Kerry Francis Bullmore Packer** (1937-      ), the son of Sir Frank Packer, became chairman of Australian Consolidated Press in 1974. He also promoted World Series Cricket in 1978-1979 and came to an agreement with the Australian Cricket Board of Control about televising test series cricket. He was born in Sydney.

**Paddington.** See **Westminster, City of.**

**Paddle steamer** is a steamship driven by paddle wheels. The first steamship was a small vessel with paddle wheels on its sides, powered by a steam engine. It was built in 1787 by John Fitch, an American inventor. In 1802, William Symington, a British inventor, built a steam tug driven by a stern paddle wheel. See **Fitch, John.**

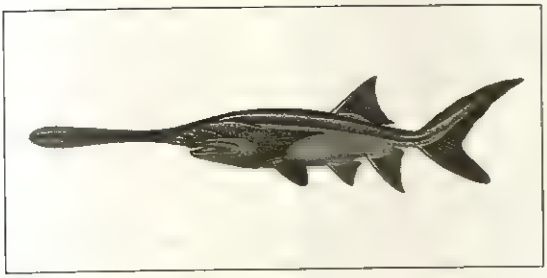
In the 1830's, screw propellers were invented. They proved to be more efficient than paddle wheels, especially in rough seas. After this time, most sea-going ships used screw propellers, though some also had paddle wheels. Paddle steamers continued to be used mostly on lakes and rivers. Sternwheel paddle steamers were used on the Mississippi River, in the United States, during the 1800's. Paddle steamers were also used on the Murray River, in Australia, from the 1850's until the railways took over much of the river trade in the 1920's. Today, only a few paddle steamers remain in use, as tourist attractions.

See also **Ship** (The first steamboats).

**Paddle steamers** are driven by paddle wheels. They were mostly used on lakes and rivers during the 1800's. Only a few remain in use; this one serves on the Murray River, in Australia.

**Paddlefish** is the name of two species of primitive freshwater fish, with sharklike fins and an elongated snout. One species lives in the United States, the other in China. The American paddlefish lives in the rivers and reservoirs of the Mississippi River drainage system, in the central-southern United States. It feeds on tiny organisms called *plankton.* It grows up to 2 metres long and may weigh over 40 kilograms. A good quality caviar is made from the fish's *roe* (eggs). The fish's flesh is also valued as food.

The Chinese paddlefish is known only in the lower



**The American paddlefish has an oarlike snout.**

reaches of the Yangtze River. It is a massive fish, up to 7 metres long, with a very long bony, pointed snout. The mouth has a huge gape. This paddlefish is thought to feed on smaller fishes. Its flesh is highly valued as food.

**Scientific classification.** The paddlefish belongs to the family Polyodontidae. The American paddlefish is *Polyodon spathula,* the Chinese paddlefish is *Psephurus gladius.*

**Pademelon** is a small kind of wallaby. The few species live in dense growth of Australian forests or swamps. They graze at dawn and dusk around the edge of the bush. Their main food is grass. They are slow breeders. The destruction of the bush and competition with introduced animals has resulted in the disappearance of pademelons from some areas. See **Kangaroo; Wallaby.**

**Scientific classification.** The pademelon belongs to the kangaroo and wallaby family, Macropodidae, genus *Thylogale.*

**Paderewski, Ignace Jan** (1860-1941), was a Polish pianist, composer, and statesman. During World War I (1914-1918), he abandoned his career as a musician to devote his energies to the cause of Polish freedom.

Paderewski was born in Podolia, now a part of Ukraine. He began his piano lessons at the age of six. When he was 12, he entered the Warsaw Conservatory.

In 1887, he began a brilliant career as a concert pianist, playing to audiences in Europe and America. Paderewski also played in South America, Australia, New Zealand, and South Africa.

During World War I, he gave concerts to raise relief funds for Poland, and he helped enlist men for the Polish Army. He represented his country at the Versailles Peace Conference and at the League of Nations. He served as prime minister, as well as minister of foreign affairs, in the Polish republic. But he remained in power for only 10 months.

In 1922, Paderewski resumed his concert performances and teaching. He made his last tour, in the United States, in 1939. Late in 1940, he moved to the United States to make his home on a California ranch.

Paderewski's compositions include the opera *Manru, Sonata in A minor* for violin and piano, six humoresques for piano, and "Polish Fantasy" and *Concerto in A minor* for piano and orchestra. His last composition, *Symphony in B minor,* is a musical picture of Poland's tragic history.

**Padlock.** See **Lock.**

**Padua** (pop. 231,337) stands on the Bacchiglione River, 35 kilometres southwest of Venice (see **Italy** [political map]). It is the oldest city in northern Italy, and its history is rich in architecture, art, and famous people. Many narrow, crooked streets are lined with arcades, and several high Roman bridges cross the various arms of the river. The city has many medieval palaces and churches. The churches include the Basilica of St. Anthony, which dates from the 1200's.

Padua's art treasures include works by such well-known masters as Giotto, Donatello, and Fra Filippo Lippi. The Roman historian Livy was born in Padua, and at one time Dante lived there. Galileo lectured for 18 years in Padua's university, which was founded in 1222 by Emperor Frederick II. The oldest botanical garden in Europe is connected with the university.

Today, Padua manufactures motor vehicle parts, refrigerators, and other machinery. It has a prosperous trade in fruit, grain, wine, and cattle.

**Paediatrics** is the branch of medicine concerned with the care of children. It deals with all aspects of a child's physical and emotional development and well-being, including the treatment of diseases and disabilities. It frequently involves preventive health care. Doctors who practise paediatrics are called *paediatricians.* These doctors provide care for children of all ages, from birth through to adolescence.

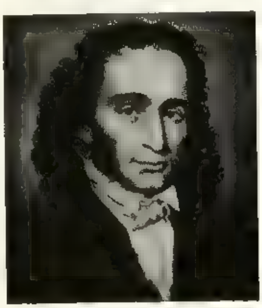
Paediatrics developed as a branch of medicine because many health problems occur mainly or only in children. For example, a disease such as chickenpox affects far more children than adults. Children are physically and psychologically different from adults, and so doctors must treat them differently. In addition, children grow rapidly and therefore change more quickly than do adults.

After qualifying, a doctor who wishes to become a paediatrician undertakes several years' specialized training in the medical care of children. Many paediatricians undertake two to three years of additional training in a particular area of paediatrics.

**Pagan** is a volcanic island in the Pacific Ocean. It is one of the northern Mariana Islands, which were part of the Trust Territory of the Pacific Islands administered by the United States. In 1986, Pagan and the rest of the northern Marianas became a commonwealth of the United States. Pagan has an area of about 50 square kilometres. The island is steep, and has several volcanoes, most of which are dormant. In 1981, an eruption of Mount Pagan, the largest volcano, destroyed most of the island's buildings and farmland. Following the eruption, the island's population, which totalled about 60 people, was evacuated.

**Paganini, Niccolò** (1782-1840), an Italian musician and composer, became one of the greatest violinists of all time. Paganini was 9 years old when he made his concert debut in Genoa, Italy.

From the age of 13, he enjoyed one triumphant concert tour after another. Paganini played quiet melodies so beautifully that his audiences often burst into tears. But he could also perform with such force and speed it was claimed that he was in league with the Devil, who guided his bow.



**Niccolò Paganini**

Once Paganini established his fame, his life

became a combination of artistic triumphs and extravagant living. At one time he pawned his violin to pay a gambling debt. A French merchant gave him one made by Giuseppe Guarnieri, so that Paganini could play a concert. Paganini left this violin to the city of Genoa, where it is kept in a museum.

At the age of 13, Paganini began to compose pieces for the violin. His works include 24 caprices for violin; two concertos for violin and orchestra, in *D major* and *B minor;* and *Moto Perpetuo (Perpetual Motion).* Paganini was born in Genoa on Oct. 27, 1782.

**Page.** See **Knights and knighthood.**

**Page, Sir Earle** (1880-1961), an Australian politician, was leader of the Country Party from 1920 to 1939. He served as prime minister for three weeks in 1939 after the death of the previous prime minister, Joseph Lyons. Page was federal treasurer from 1923 to 1929, minister for commerce from 1934 to 1939 and in 1941 and 1942, and minister for health from 1937 to 1939 and from 1949 to 1955. In 1955, he became the first chancellor of the University of New England. Earl Christmas Grafton Page was born in Grafton, New South Wales, Australia. He was a doctor before entering politics.

**A pagoda** in Nanjing, China, *above,* was built in the 1920's. The nine-storey structure has a steel frame and stone walls.

**Pageant** is a spectacular show. The term comes from the Latin word *pagina,* meaning *platform.* In England, by the 1500's the word had become *pageant.* Then it meant a movable platform that was wheeled to the public square to present mystery plays and other dramas. Today, the word means the dramatic production itself. Most pageants are plays of special significance, such as a drama portraying the growth of a city or the development of medicine. A pageant does not have to be a play. The Lord Mayor's Show, held annually in the City of London, is a pageant.

**Pagliacci, I.** See **Opera** (The opera repertoire).

**Pago Pago.** See **American Samoa.**

**Pagoda** is a type of tower commonly associated with Buddhist temples. Pagodas exist mainly in China, Japan, and parts of India and southeastern Asia. A typical pagoda has from 3 to 15 storeys of decreasing size from bottom to top. Each storey of the tower has an overhanging, elaborately decorated tile roof that curves upward at the edges. In many cases, fancifully carved wooden beams and posts support the structure.

In China, most pagodas have eight sides and an uneven number of storeys. They are made of wood, masonry, glazed tile, or porcelain and are decorated with ivory, bone, and stonework. Originally, each element in the design of a pagoda had religious meaning. Many Chinese people believed a pagoda brought wealth and happiness to the surrounding community. Japanese pagodas developed from Chinese models. Most Japanese pagodas are made of wood. The ground floor may contain shrines and images, and the upper storeys may be used to view the surrounding area. In Taiwan, many pagodas house the ashes of cremated Buddhists.

Pagodas originated in India from the form of Buddhist burial mounds and temples called *stupas.* As Buddhism spread eastward, the pagoda form spread with it. Beginning in the 1600's, imitation pagodas were built in many European gardens.

See also **Burma** (The arts; picture); **Temple.**

**Pahang** is an eastern state of Peninsular Malaysia which developed an offshore oil and gas industry in the 1980's. Pahang is bounded by Terengganu and Kelantan to the north, by Perak and Selangor to the west, and by Negeri Sembilan and Johor to the south. The South China Sea lies to the east.

**People and government.** About 67 per cent of the population are Malay, 26 per cent Chinese and 7 per

**Facts in brief about Pahang**

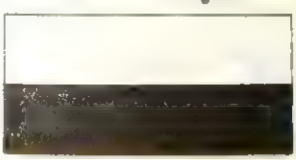
**Population:** *1991 census*—1,036,724.
**Area:** 35,965 km².
**State capital:** Kuantan.
**Largest cities:** Kuantan, Bentong, Temerloh, Mentakab, Lipis.
**Chief products:** *Agriculture*—cocoa, oil palm, rubber, tea, timber, vegetables. *Mining*—natural gas, oil.

**A boat trip in Pahang** goes down the Tahan and Terenggan rivers in the Taman Negara national park. The trip involves shooting several sets of rapids, and skilled boatmen are needed. The vast park covers more than 4,300 square kilometres and is full of wild life. Most of the park is in Pahang.

cent Indian. The population lives mainly on the coast, along the rivers, and on the eastern slopes of the mountains in the west. In the mountainous interior there are large communities of Malaysian aborigines. These people, known in Malay as *orang asli* (original people), were the first inhabitants of the area.

The head of state of Pahang is a hereditary ruler known as a *sultan*. The state assembly has 33 seats. See also **Malaysia, Government of.**

**Economy.** Agriculture remains an important source of employment. The main commercial crops are oil palm and rubber. Cocoa, tea, and vegetables are also important crops. The timber industry uses the resources of Pahang's great forests and extracting and processing timber provides employment.




**The flag of Pahang** has a white stripe representing the ruler and a black stripe representing the *rakyat* (the people). The emblem of Pahang has a spearhead in the shape of a coffee-tree leaf, and elephant tusks that symbolize the authority of the ruler.


**Pahang** is a state in the middle of Peninsular Malaysia. It has oil and gas resources under the South China Sea.

The state has substantial mineral resources. In the 1980's, offshore natural gas and oil were discovered in commercial quantities near Kuantan. This led to the establishment of processing and servicing facilities.

**History.** There has been human settlement in Pahang since prehistoric times. Archaeologists found Stone Age remains on the banks of the Tembeling River (see **Stone Age**). In the 1200's, Pahang was a dependency of the Sumatran kingdom of Srivijaya (see **Srivijaya**).

In the 1300's, the area came under control of the Javanese kingdom of Majapahit (see **Majapahit**). Chinese sources show that in this period Pahang built up a thriving foreign trade. In the 1400's, the powerful kingdom of Melaka ruled Pahang, and the son of the Melaka ruler was installed as the sultan of Pahang. The British came to the region at the end of the 1800's. They believed that Pahang contained vast mineral wealth, including deposits of gold and tin. In 1887, the sultan of Pahang accepted the appointment of a British agent to open the state to "commerce and civilization." Later the British also appointed a government official called a *resident* to assist in the administration of Pahang. Although some local leaders cooperated with the British, there was considerable opposition to the new rulers. In 1891, a district chief named Dato Bahaman led an open rebellion against the British. Order was restored in 1895.

In 1896, the British formed the Federated Malay states, which included Pahang. The pace of economic change in Pahang was slow. Although there was some tin mined near the Selangor and Terengganu borders, the mineral wealth of the state was not as great as had been hoped. Communications both into and within the state were poor, and this lack of contact limited the development of commercial crops. In 1948, Pahang joined the Federation of Malaya, which became independent from British rule in 1957.

**Pahlavi, Mohammad Reza.** See Mohammad Reza Pahlavi.

**Pahlavi, Reza Shah.** See Reza Shah Pahlavi.

**Paignton** is a popular seaside resort and a fishing port in Devon, England. It is part of the local government district of Torbay. Places of interest include the Bible Tower, which is the remains of a palace of the Bishops of Exeter built in the 1300's. See also **Torbay.**

**Pain** is an unpleasant sensation. People generally associate pain with physical injuries or illnesses. But feelings and emotions can also produce pain. For example, annoyance can produce painful tension in the neck mus-

cles. Pain is a highly personal sensation. An injury that causes severe pain in one person might produce only moderate pain in another. Doctors find it difficult to measure pain and must rely largely on the patient's description of the sensation. Headache pain, for instance, provides little measurable evidence, yet headache sufferers often report extremely severe pain.

Nerves carry pain signals to the brain in the form of electrical impulses. The brain responds to these signals in different ways, depending on the situation. In some cases, the brain does not react immediately to the signals. For example, an athlete injured during a game may not notice any pain until the contest is over. In such cases, the brain ignores the pain signals because it is concentrating on other tasks.

Severe pain can serve as a useful warning that something is physically wrong with the body. In most such cases, the pain disappears after the fault is corrected. Doctors refer to such short-lived, severe pain as *acute pain.* It differs from *chronic pain,* which lasts a long time. Some chronic pain results from disorders that cannot be completely cured, such as certain types of cancer and arthritis. But in other cases, pain persists even though its physical cause has been corrected. This type of chronic pain resists treatment and can lead to mental breakdowns and drug abuse. Some persons undergo many unsuccessful surgical operations in an effort to control such incurable pain.

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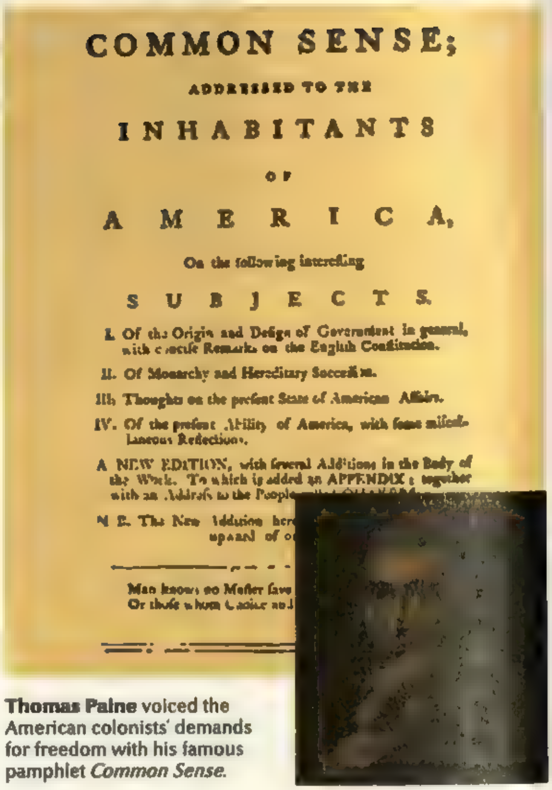
**Paine, Thomas** (1737-1809), was a famous English-born American pamphleteer, agitator, and writer on politics and religion. His writings greatly influenced the political thinking of the leaders of the American Revolution, and he became a famous figure in Paris during the French Revolution. "I know not," wrote former U.S. President John Adams in 1806, "whether any man in the world has had more influence on its inhabitants or affairs for the last thirty years than Thomas Paine."

Paine's opinions and personality aroused strong feelings in those around him. Some admired him greatly, but others hated him fiercely. Many historians regard Paine as a patriot who did much for America and asked nothing in return. He stated clearly and concisely political ideas that others accepted and supported, if necessary, to the point of death. Yet Paine died a social outcast.

**Early life.** Paine was born in Thetford, England, on Jan. 29, 1737. His family was poor, and he received little schooling. He began working at the age of 13. At 19, he went to sea for a time. Later, he served as a customs collector in London, but was discharged. His first wife died, and he was separated legally from his second wife. Paine was alone and poor in 1774. But he gained the friendship of Benjamin Franklin, then in London, who advised him to go to America.

**American revolutionary.** Paine arrived in America with letters of recommendation from Franklin. Paine soon became contributing editor to the *Pennsylvania Magazine,* and began working for the cause of independence. In 1776, he published his pamphlet *Common Sense,* a brilliant statement of the colonists' cause. This


COMMON SENSE;

ADDRESSED TO THE

INHABITANTS

OF

AMERICA,

On the following interesting

SUBJECTS.

I. Of the Origin and Design of Government in general, with concise Remarks on the English Constitution.

II. Of Monarchy and Hereditary Succession.

III. Thoughts on the present State of American Affairs.

IV. Of the present Ability of America, with some miscellaneous Reflections.

A NEW EDITION, with several Additions in the Body of the Work. To which is added an APPENDIX; together with an Address to the People

N. B. The New Addition here
upward of o

Man knows no Master save
Or those whom Choice and

**Thomas Paine** voiced the American colonists' demands for freedom with his famous pamphlet *Common Sense.*

pamphlet demanded complete independence from Great Britain and the establishment of a strong federal union. It also contained a brilliant attack on the idea of monarchy and inherited privilege. Paine asserted that the American Revolution would begin a new era in world history. "The birthday of a new world is at hand," he wrote. George Washington, Thomas Jefferson, and other colonial leaders read it with approval, as did hundreds of thousands of ordinary Americans. *Common Sense* became the most widely circulated pamphlet in American history to that time. In December 1776, Paine followed *Common Sense* with a series of pamphlets called *The Crisis.* The first of these pamphlets began, "These are the times that try men's souls. The summer soldier and the sunshine patriot will, in this crisis, shrink from the service of their country . . . Tyranny, like hell, is not easily conquered." Washington had the pamphlet read aloud to his soldiers. Paine's bold, clear words encouraged the Continental Army during the darkest days of the war.

Paine served as a soldier in 1776. He also worked with a group of Pennsylvanians to create a democratic constitution for the state. In April 1777, he became secretary to the Congressional Committee of Foreign Affairs. His honesty in exposing questionable actions by Silas Deane, American commissioner to France, made him enemies, and Paine was forced to resign his position.

**French revolutionary.** Paine went to France in 1787 and then to England. While in England in 1791 and 1792, he published his famous *Rights of Man,* replying to Edmund Burke's attack on the French Revolution (see

**Burke, Edmund**). William Pitt's government suppressed this work, and Paine was tried for treason and outlawed in December 1792. But he had returned to France.

The National Assembly of France made Paine a French citizen on Aug. 26, 1792. He became a member of the National Convention. But his friends, members called the Girondists, lost power in the Convention. Then he was expelled from the Convention, deprived of his French citizenship, and imprisoned for more than 10 months (see **Girondists**). The American minister James Monroe claimed him as an American citizen and obtained his release.

While in prison, Paine worked on *Age of Reason.* It stated his views on religion, and many people called it the "atheist's bible." It began: "I believe in one God, and no more; and I hope for happiness beyond this life." Although Paine believed in God, he disagreed with many accepted church teachings and saw the established churches of Europe as obstacles to social change. His unorthodox views on religion made him one of the most hated men of his time.

**Dies neglected.** In 1802, President Thomas Jefferson arranged for Paine's return to the United States. Paine found that people remembered him more for his opinions on religion than for his services to the American Revolution. During his last years, Paine was poor, ill, and a social outcast. He was buried on his farm in New Rochelle, New York, but 10 years later his body was removed to England. The location of his grave is unknown.

**Paint** is a substance that provides colour and protection for surfaces. It is used on the walls and the outside of buildings, on cars, on furniture and household appliances, and on many machines and machine parts. Most paints are applied to a surface as liquids and then dry to form a thin solid film. A typical coat of paint is about 0.08 millimetre thick.

Paint consists of one or more finely ground *pigments* and a liquid *vehicle.* Pigments determine the colour of the paint and provide it with certain other properties as well. Pigments commonly used for their colour include titanium dioxide (white), iron oxide (yellow or red), phthalocyanine (blue or green), and toluidine (bright red). Clay, mica, and talc are often added to paint to increase its resistance to wear. These semitransparent materials are called *extenders* or *inert pigments.* Such pigments as red lead and zinc chromate help paint protect metal surfaces against rust. Pigments composed of fine metal powders are included in paints designed to give surfaces a metallic finish.

A paint's vehicle carries the pigment and binds it to a surface. Paint vehicles are composed of one or more *resins* and a *solvent.* Resins are sticky substances obtained from plants or manufactured by means of complicated chemical processes. They include acrylics, alkyds, epoxies, and vinyls. Resins help determine the adhesive quality, drying time, gloss, and hardness of paints. Many are colourless.

The solvent is the ingredient that makes paint a liquid. The solvent a paint contains depends on the resins that are being used. Most household paints use water as a solvent. Other commonly used solvents include mineral spirits, naphtha, and xylene. Solvents are sometimes called *paint thinners.*

The major use of paint is decoration. But paints are also used to protect surfaces against corrosion. Some paints provide mechanical protection; aluminium becomes less vulnerable to scratches when painted. Paint on aeroplanes reduces friction with the air.

### Kinds of paint

There are many kinds of paint. Chemists often classify paints according to the way they *cure* (dry). For example, some paints cure simply through the evaporation of the solvent, which is accompanied by the hardening of the resin. Others, however, form a solid film only after a chemical called a *catalyst* has triggered a reaction to bond the resin particles together. This reaction follows the evaporation of most of the solvent.

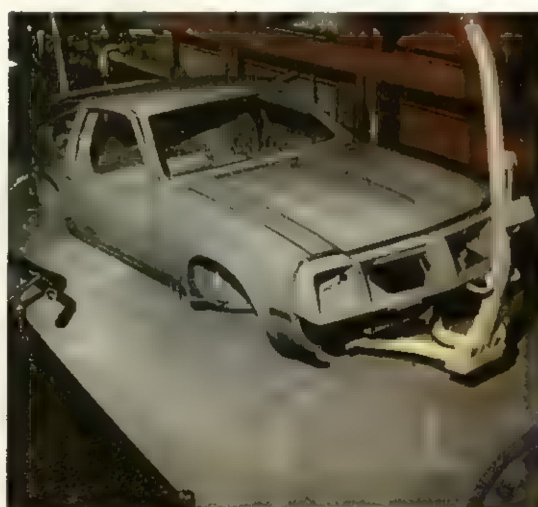
Paints are also grouped according to their use. For example, *household paints* are used to decorate and protect houses, office buildings, and other structures. *Industrial paints* are used on a wide variety of consumer products and industrial equipment.

**Household paints** include paints for the walls, ceilings, floors, and exteriors of buildings.

Most household paints are *emulsion* or *latex paints.* Latex (natural rubber) was used as the resin in early *water-based paints*—that is, paints that use water as a solvent. Polyvinyl acetate or acrylic resins have replaced latex in such paints.

Emulsion paints cure by *coalescence.* In this process, the resin molecules bond together to form a dry paint film. This bonding occurs as the water evaporates from the painted surface.

Emulsion paints are not flammable and have little odour. They dry to a film that can be easily cleaned with soap and water. Interior emulsion wall paints can tolerate repeated washings, but they are not durable enough for surfaces exposed to the weather. Sunlight can make paint fade in colour. Wind, rain, and extremely hot or cold temperatures can cause paint to crack, chip, blister, and peel. As a result, exterior house paints have been



**A rustproof coating** is applied to a new car by submerging the car body in a tank of primer for three minutes. Later an industrial paint will be baked on over this primer.

developed with certain resins that provide increased resistance to weathering.

Most exterior house paints are emulsion paints. However, some exterior paints are *oil-based*—that is, their solvents come from petroleum. They use linseed oil or a similar oil as a resin. These oil-based paints cure by *oxidation*. After most of the solvent has evaporated, the resins combine chemically with oxygen in the air to form a hard film.

Special paints called *primers, sealers,* or *undercoats* are used for painting such porous surfaces as bare wood or plaster. Primers are applied as the first coat to form a smooth foundation for further coats of paint.

Several countries restrict or even prohibit the use of lead pigments in household paint, or require a health warning if the lead content is over a predetermined level. Governments took this action after the discovery that some children had developed lead poisoning as a result of eating chips of dried paint with a high lead content.

**Industrial paints** are used on such consumer products as cars, furniture, and household appliances. They also include coatings that protect machinery and other industrial equipment against strong chemicals, rust, and extremely high temperatures. Some industrial coatings, such as stains and primers, are available to consumers for use in the home.

Most car manufacturers paint their cars with coatings that contain acrylic resins and cure by being baked. Many kitchen and laundry appliances also have baked-on finishes. Such coatings produce a surface that is extremely hard. It is resistant to harsh chemicals and has colours that do not fade easily.

Manufacturers of wooden furniture often use wood stains on their products. The pigments in wood stains are highly transparent. They are dissolved in a vehicle that enables the stain to soak into the wood rather than to stick to its surface as a film. Stains darken the colour of the wood, but allow the wood grain to show through. After wood is stained, manufacturers apply a clear, protective finish to it using lacquer or shellac. These finishes cure by *solvent evaporation*—that is, the resins solidify into a hard coat as the solvent evaporates. These finishes dry quickly and produce a shiny surface. After they have hardened, such finishes can be redissolved with the same solvents originally used in the vehicle. Some wood products are finished with varnish, an oil-based coating that dries by oxidation.

Iron and steel may rust if they come into contact with moisture and oxygen. For this reason, many products made of iron or steel are coated with special rustproof primers and finish coats. Metal primers have high proportions of rust-resistant pigments. Some of these paints contain ingredients that penetrate rust to drive out oxygen and moisture. Finish coats cover the metal primer and seal it. In general, the primer protects the metal and the finish coat protects the primer. Some metal products are covered by enamels, which contain alkyd resins and dry by oxidation.

The most durable coatings available are generally used on machinery and other industrial equipment. They are often based on epoxy or polyurethane resins, which cure by chemical reaction. The chemical industry uses a number of such paints to protect the surfaces of pipes and containers that are used to store or carry harsh chemicals. Special heat-resistant coatings have been developed for high-speed aircraft, space vehicles, and equipment used in certain industrial processes. Some of these special paints can withstand temperatures as high as 650 °C.

### How paint is made

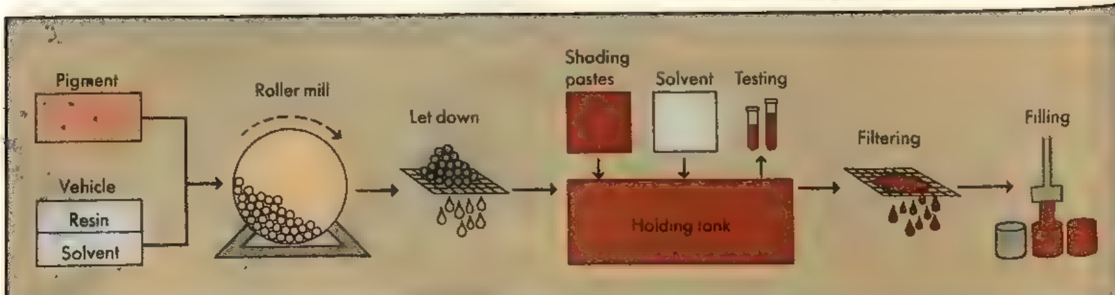
All paints are manufactured according to a similar process. The basic steps of this process are (1) grinding, (2) let down, (3) shading, and (4) thinning.

**Grinding.** Batches of paint vary in size, but many are as large as 5,700 litres. To produce a batch of paint, manufacturers first load measured amounts of pigment, resin, and various liquid chemicals into one of several types of grinding mills. The mill grinds the liquid and dry ingredients into a fine, uniform material that is called *mill paste*.

Manufacturers choose a mill according to the hardness of the pigments and the fineness of grind required for the paint. Latex house paints are usually prepared in a mill called a high-speed disperser. The high-speed disperser has circular blades with saw-toothed edges. The blades rotate at high speeds, causing the pigment parti-

**How paint is made**

Paint is made by mixing coloured pigment powder in a liquid *vehicle* that contains one or more resins and a solvent. The pigment and vehicle are made into a fine paste by the tumbling action of balls or pebbles in a roller mill. During *let down*, the paste is pumped from the mill and strained. In a holding tank, the colour is adjusted by adding shading pastes, and the mixture is thinned with solvent. After final testing, the paint is filtered and poured into containers for shipment.



cles to collide with one another and break into smaller pieces.

Other mills have a large, hollow, rotating steel cylinder partly filled with *grinding media.* Ball mills contain steel balls that measure about 1.5 centimetres in diameter. Pebble mills contain flattened ceramic balls measuring about 3.5 centimetres in diameter.

As the mill turns, the grinding media tumble against one another, grinding the pigment between them. Most of these mills rotate at about 16 revolutions per minute. The grinding process may last 24 hours.

Sand mills or bead mills can produce fine grinds more quickly than other mills. These mills shoot tiny glass beads through the pigment at very high speeds. The mills can supply finely ground paste continuously or in batches.

**Let down.** After the pigment has been ground, more resin is added to the paste in the mill, along with a small amount of solvent. The paste is then "let down"—that is, it is pumped out of the mill through a strainer to a holding tank. The strainer removes the grinding media from the paste. Workers rinse the mill with more solvent, which is then mixed with the rest of the material in the holding tank.

**Shading,** also called *tinting,* is probably the most critical step in the manufacture of paint. In this step, paint producers compare samples of the material in the holding tank with colour standards they keep on file. They then add small amounts of *shading paste* to the batch to adjust its colour to the standard. Shading pastes are highly concentrated blends of ground pigments and a vehicle. In many cases, shading pastes of several different colours must be added to a batch in order for it to match the standard.

**Thinning.** After the batch has been shaded to specification, it is thinned to the desired *viscosity* (thickness) by carefully adding solvent to it. Manufacturers then test the final product for quality. The paint is then filtered and poured into containers for shipment.

### How to use household paint

**Selecting the paint.** Household paint is available in matt, semigloss, and gloss finishes, and in a wide variety of colours. The nature of the surface to be covered plays an important role in the selection of the finish and colour of paint. For example, a single coat of paint is often sufficient when covering a light surface with a dark colour. But several coats may be required when painting light over dark.

Matt paints are often used on surfaces that have a number of irregularities. These paints help hide such flaws. Gloss finishes, on the other hand, are smooth and shiny, and they readily show up any surface defects. However, gloss paints are more durable than are matt paints. Paints with intermediate levels of gloss are often called *eggshell, satin,* or *velvet.*

**Preparing the surface.** Poor surface preparation is a major cause of paint failure. The surface to be painted must be free of dirt, dust, grease, loose paint, moisture, oil, and wax in order for the new paint to stick to it properly. Often, washing a surface with soap and water is sufficient. But some surfaces may require scraping, brushing with a wire brush, or sanding. Others may also have cracks or holes that need to be sealed.

**Stirring and filtering.** Some paints should be stirred before they are applied in order to ensure that they have a uniform consistency. One of the best methods is to stir it in a figure of eight motion with a paint paddle. The paddle should be lifted occasionally to raise heavy pigments from the bottom of the can.

Before painting, many people strain paint through a special paint filter, a fine screen, or a nylon stocking. This procedure is especially helpful when using old or leftover paint, which might contain dirt or pieces of dried paint film.

**Applying the paint.** Paint may be applied with brushes, spray equipment, rollers, or paint pads. Small objects and irregular surfaces can best be painted with brushes or sprayers. Large, flat surfaces can be painted faster with sprayers, rollers, or paint pads than with brushes. However, some people prefer to use brushes for all surfaces.

Brushes are made of pig bristles or synthetic fibres. Pig-bristle brushes are used to apply oil-based paints, and synthetic-fibre brushes to apply either oil-based or emulsion paints. Paint should be spread on a dry area

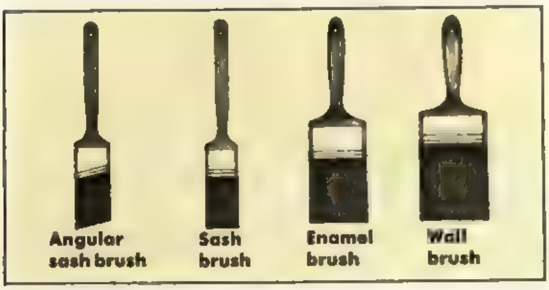
**Filling cans with paint** is done automatically. This machine fills and covers cans after the paint has been tested and filtered. Handles are then applied and the cans of paint are ready for shipment.

and then brushed toward the wet edge of a previously painted area. This method of applying paint helps prevent streaking.

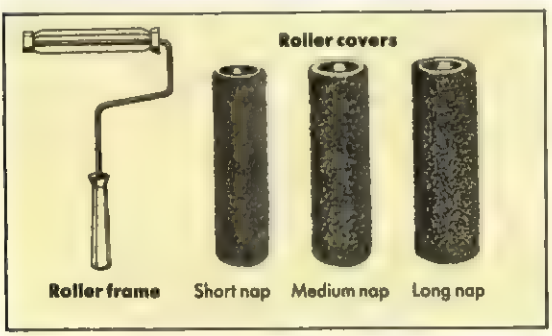
Spray painting produces a smooth coat of paint. Spray equipment causes thinned paint to form droplets under pressure. When spraying paint, painters wear filter masks to avoid inhaling paint mist and vapour. All surfaces not to be painted are covered to protect them from the fine spray.

**Types of paint applicators**

Paint may be applied with brushes, rollers, spray guns, or pads. The choice of which type of applicator to use depends on the size, shape, and texture of the surface to be painted.




**Paint brushes** are especially good for painting small objects or irregular surfaces. Narrow sash brushes can reach into tight corners. Wider brushes are used for broad areas, such as walls.




**Paint rollers** paint large, flat surfaces quickly. Roller covers that have short fibres, or a short *nap*, are good for painting smooth surfaces. Covers with a longer nap are used for rough surfaces.


**Spray guns and paint pads** allow quick coverage of large areas. In addition, small objects and irregular surfaces can be painted easily with spray paint from aerosol cans.

Rollers and pads hold paint in fibres, the length of which determines the *nap* of the applicators. Rollers with short naps are suitable for applying thin paints on smooth surfaces. Long-napped rollers work better for thicker paints and textured surfaces. An even coat is produced by rolling paint on a surface in crisscross and up-and-down strokes. Each rolled strip of paint should overlap the wet edge of the previously painted area to avoid streaks. Paint pads are made of foam, mohair, or synthetic fibres. They hold a large amount of paint without dripping or splattering.

## The history of paint

Prehistoric people made paints by mixing vegetable and earth pigments with water or animal fat. They painted on cave walls, on tombs, and on their bodies. Some caves in western Europe have walls that were painted more than 20,000 years ago.

By 2000 B.C., Egyptian tombs were being painted with materials similar to paints made today. These paints were made of crudely refined pigments, natural resins, and drying oils. The Egyptians imported pigments from as far away as India. By 1500 B.C., painting and paint-making had become known in Crete and Greece.

The Romans learned how to make paints from the Egyptians. After the fall of the Roman Empire, in the A.D. 400's, paint-making became a lost art until the English began making paints toward the end of the Middle Ages. They used paints chiefly on churches at first, and later on public buildings and the homes of wealthy people.

During the 1400's and 1500's, Italian artists and craftworkers developed their own paint-making processes. Unfortunately, they kept their formulas secret, and as a result, the process of making a particular paint often died with its inventor.

The commercial manufacture of paints began in Europe and the United States during the 1700's. The early manufacturers of paint ground their pigments on a stone table with a round stone. They used such materials as eggs, coffee grounds, and skimmed milk. They thinned these paints with water. In the late 1800's, grinding and mixing machines were developed that enabled manufacturers to produce large volumes of paint.

Improvements in paint technology closely paralleled advances in chemistry during the 1900's. Many synthetic resins were developed, as were a number of new pigments. Paints became increasingly specialized to meet the specific demands of industry. Many of today's industrial coatings provide high levels of protection against rust, harsh chemicals and gases, and extremes of temperature.

**Related articles** in *World Book* include:

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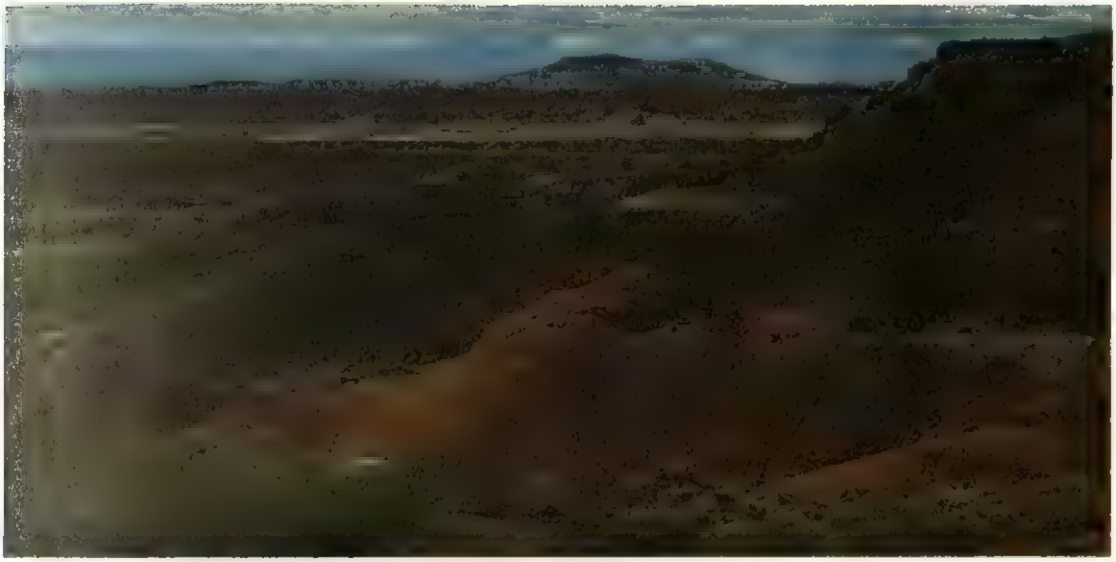
Painting (Painting materials)
Pigment
Resin
Resin, Synthetic
Shellac
Stain
Talc
Titanium
Tung oil
Varnish
Vegetable oil

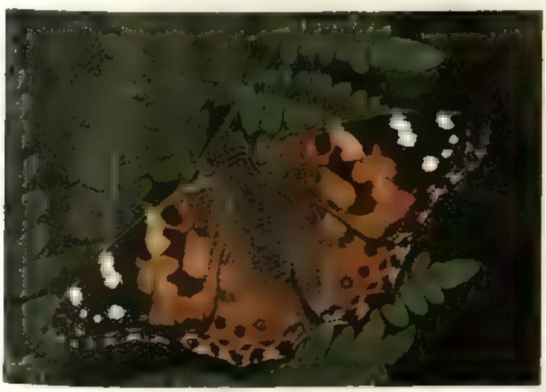


**The Painted Desert,** a wasteland of striking colour, covers a large area in north-central Arizona, U.S.A. Its hills and terraces reveal brilliant shades of blues, reds, and yellows.

**Painted Desert** is a brilliantly coloured plateau region that extends for about 320 kilometres along the Little Colorado River in north-central Arizona, U.S.A.

The desert received its name from early Spanish explorers, who called it *El Desierto Pintado,* meaning *The Painted Desert.* It is a fantastic wasteland, with *buttes* (isolated steep hills), *mesas* (flat-topped hills), pinnacles, and valleys formed by wind and rain cutting into shale-like volcanic ash over many years. The pastel colours of the desert add to its beauty, especially as heat, light, and dust often seem to change the colours from blue, amethyst, and yellow to russet, lilac, and red. The Painted Desert is particularly beautiful at sunrise and sunset, when the colours are brilliant and the shadows deep. The bright reds and yellows of the desert come from iron oxides—hematite (red) and limonite (yellow).

Several U.S. national monuments are in the Painted Desert. These include the Sunset Crater, a volcanic cinder cone (see **Volcano**), and the Wupatki National Monument, which contains Indian prehistoric dwellings.



**The American painted lady** is often found on mountain slopes.

**Painted lady** is the name of two species of butterflies, so named because of their attractive wing patterns. The wings are 5 centimetres across when open and have marbled markings. The underwings are pink, buff, and brown, and the upper wings are mainly orange brown. Painted lady butterflies often settle on bare ground and bask in the sun with their wings wide open.

Painted lady butterflies have a rapid, powerful flight and undergo long migrations. Each spring, they migrate from North Africa to Europe across the Mediterranean Sea. Some of the butterflies migrate back to Africa in late summer, but most die in Europe during the winter.

The female painted lady lays small green eggs singly on the underside of the leaves of plants such as thistles, nettles, and burdock. The larva of the American painted lady feeds on plants such as everlasting flower and cudweed. The larva, or caterpillar, has a dark head, and a yellowish-green body mottled with black, with two yellow side stripes. It feeds on the underside of a leaf, then moves to the upper surface. The caterpillar spins a layer of silk which protects it while feeding.

**Scientific classification.** The painted lady is *Vanessa cardui,* and the American painted lady is *V. virginensis.*

See also **Butterfly** (picture: Brush-footed butterflies).

**Painter** refers to the artist who paints pictures, and also to the skilled worker in the building trades. Painters on construction projects work on both the outside and the inside of a structure. A painter with a talent for colour and design may become an interior decorator.

For biographies of artists who are painters, see the *Related articles* section at the end of the **Painting** article.

**Painter's colic,** which is sometimes called *lead colic,* is a severe pain in the abdomen due to lead poisoning. White and red lead in paints can enter the body through the skin, and lead vapours may be breathed in through the lungs. Besides the colic, lead poisoning brings on weakness, anaemia, constipation, and trembling.

See also **Lead poisoning.**

*The Children's Afternoon at Wargemont* by Pierre Auguste Renoir. 1884. Oil on canvas. 1.27 by 1.73 m. Staatliche Museen, Preussischer Kulturbesitz, Nationalgalerie, Berlin

**Masterpieces of painting** may deal with any subject. The paintings by Renoir, *above,* and Bruegel, *lower right,* show how great painters can turn even simple scenes of everyday life into works of art. Some paintings have no subject at all. For example, Hofmann's work, *upper right,* is an arrangement of bright colours.

# Painting

**Painting** is one of the oldest and most important arts. Since prehistoric times, artists have arranged paint on surfaces in ways that express their ideas about people and the world. The paintings that artists create have great value for humanity. They provide people with both enjoyment and information.

People enjoy paintings for many reasons. They may think a painting is beautiful. People may like the colours that the painter used or the way the artist arranged the paint on the surface. Some paintings interest people because of the way the artists expressed some human emotion, such as fear, grief, happiness, or love. Other paintings are enjoyable because they skilfully portray nature. Even paintings of such everyday scenes as people at work and at play and of such common objects as food and flowers can be a source of pleasure.

Paintings also teach. Some reveal what the artist felt about important subjects, including death, love, religion, and social justice. Other paintings tell about the history of the period during which they were created. They provide information about the customs, goals, and interests of the people of past societies. Paintings also tell about such things as the buildings, clothing, and tools of the past. Much of our knowledge about ancient times comes from painting and other arts, because many early societies left few or no written records.

Each new style of painting in some way grows out of the styles that went before it. Each great artist adds to the achievements of earlier painters and, in turn, influences later painters. Many different factors have shaped the history of painting. These include geography, national characteristics, religion, historic events, and the development of new materials. Throughout history, painting has reflected our changing world, and artists have given us some of the best records of the growth of civilization.

The first part of this article tells about the wide variety of subjects that artists paint. It describes how painters express themselves by the way they handle their subjects. The article then goes on to discuss the elements of painting and the materials and techniques used by painters. Finally, it traces the history of painting from prehistoric times to the present day. Colour reproductions of important paintings are used to illustrate information that is discussed in the text, and the text, in turn, describes the pictures.

*The Golden Wall* by Hans Hofmann. 1961. Oil on canvas.
1.52 by 1.84 m. The Art Institute of Chicago

*Return of the Hunters* by Pieter Bruegel the Elder. 1565. Oil on wood.
1.17 by 1.62 m. Kunsthistorisches Museum, Vienna, Austria

# Famous artists and their paintings

The 116 paintings reproduced in colour in this article are listed below. These pictures were selected to represent the most important periods and styles in the history of painting. Each reproduction is accompanied by the following information, when available: the year the painting was finished, the medium in which it was created, its size, and its present location.

**Painter, painting, and page number**

Lascaux Cave, France

Prehistoric cave painting
by an unknown artist
About 15,000 B.C. Horse
about 142 cm long.

University Art Museum, Berkeley, California, U.S.A.

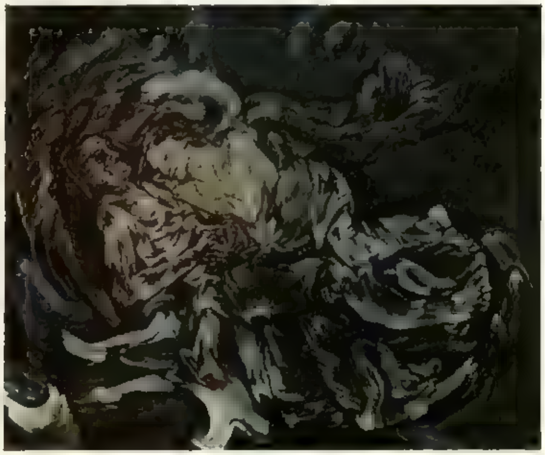
*60 T-Bird*
by Robert Bechtle
1968. Oil on canvas.
1.83 by 2.50 m.

It would be hard to find a subject that no one has ever tried to paint. Artists paint the things they see around them—people, animals, nature, and nonliving objects. They also paint dreamlike scenes that exist only in the imagination. An artist can reach back into the past and paint a historical event, a religious story, or a myth. Some artists paint pictures that show no clear subject matter at all. Instead, they arrange the paint in some abstract way that expresses feelings or ideas that are important to them.

Since prehistoric times, many artists have painted the subjects that were most important to their societies. For example, religion was particularly important in Europe during the Middle Ages, and most of the paintings created then were religious. The two pictures shown at the top of this page were painted thousands of years apart, and they seem to be unrelated. But they are related, because both artists dealt with things of great importance in their times. A prehistoric artist painted the animal on a cave wall in France, in about 15,000 B.C. The artist lived

The Phillips Collection, Washington, D.C.

*The Uprising* by Honoré Daumier
About 1860. Oil on canvas.
88 by 113 cm.



Kunstmuseum, Basel, Switzerland

*The Tempest* by Oskar Kokoschka
1914. Oil on canvas.
1.81 by 2.21 m.

at a time when animals served as the main source of food and clothing for human beings. The American artist Robert Bechtle painted the picture of a man and his car, called *60 T-Bird,* in 1968. The car was then and still is the most important means of transportation in the United States.

All great paintings, regardless of subject matter, share a common feature. They do more than just reproduce with paint something that exists, existed, or can be imagined. They also express the painter's special view about a subject.

**People** have always been a favourite subject of painters. Artists have shown people in their paintings in many different ways.

The people in Pierre Auguste Renoir's *The Children's Afternoon at Wargemont* (page 28) are part of a simple scene from everyday life. This painting shows a French family of the late 1800's relaxing in their home. It communicates to the viewer a feeling of contentment and happiness and provides details about the clothing, furniture, and playthings of the time.

Honoré Daumier used people for an entirely different reason in his *The Uprising* (page 31). Daumier's people are taking part in the Revolution of 1848, a series of revolts by the lower classes in Europe. Daumier was not interested in showing details of his subjects' clothing or surroundings. Instead, he crowded the people together in a scene that suggests action. He made the people seem more like symbols of the revolutionary spirit than like real human beings.

The people in Oskar Kokoschka's *The Tempest* (page 31) are even less realistic than those in *The Uprising.* The two people are caught up in a mysterious swirling scene that cannot be explained in any logical way. The artist painted the people this way to show powerful emotions that apparently swept the couple away from the activities of everyday life.

The people in Marc Chagall's *Birthday* (page 33) are completely divorced from reality. Chagall showed people doing fantastic things that no one can do in real life. The figures bend unnaturally and float through the air. They are part of the world of imagination. Even the room seems dreamlike.

**Religious subjects** dominated painting in some parts of the world for hundreds of years. A large part of all the painting ever done in Asia is religious. Medieval Europeans painted almost nothing but religious subjects. Painters of the European Renaissance, which followed the Middle Ages, painted more religious pictures than any other kind.

Religious pictures tell stories about gods and holy people and teach moral lessons. In *Christ of the Apocalypse* on this page, an unknown Spanish painter showed Jesus as a powerful, stern figure who rules the world. Jesus is surrounded by symbols, including the first and last letters of the Greek alphabet. These letters mean that He is the beginning and end of all things—everything. Many religious painters showed their subjects as powerful and stern, and others showed their subjects as loving or suffering figures. In one way or another, most religious paintings reflect the artist's respect for religion. But a painting can express an opposite attitude toward

Museum of Catalan Art, Barcelona, Spain

*Christ of the Apocalypse*
by an unknown Spanish artist
1100's. Fresco. Main figure larger than life size.

Carter Burden Collection, New York City

*Study After Velázquez: Portrait of Pope Innocent X*
by Francis Bacon
1953. Oil on canvas.1.53 by 1.18 m.

Mauritshuis, The Hague, the Netherlands

*View of Haarlem* by Jacob van Ruisdael
About 1670. Oil on canvas. 56 by 62 cm.

Graphische Sammlung Albertina, Vienna, Austria

*Young Hare* by Albrecht Dürer
1502. Watercolour. 25 by 23 cm.

The Museum of Modern Art, New York City, acquired through the Lillie P. Bliss Bequest

*Birthday* by Marc Chagall
1915. Oil on cardboard. 81 by 100 cm.

Würzburg Residenz, Würzburg, Germany (c) Verlag Gundermann

*Allegory of the Marriage of Frederick Barbarossa and Beatrice of Burgundy* by Giovanni Battista Tiepolo
1752. Fresco. Figures slightly smaller than life size.

Gallerie dell'Accademia, Venice, Italy

*Saint Mark Rescuing a Slave* by Tintoretto
1548. Oil on canvas. 4.15 by 5.41 m.

Wall in an alley in Chicago

*Wall of Love* by William Walker
1971. Figures larger than life size.

religion. Compare *Christ of the Apocalypse* with the painting below it by the modern artist Francis Bacon. Bacon's religious figure, a pope, is distorted, frightened, and in pain.

**Landscapes and seascapes.** Many artists turn to nature for their subject matter. They paint scenes called landscapes and seascapes that try to capture the many moods of nature. Compare Jacob van Ruisdael's landscape *View of Haarlem* (page 33) and Winslow Homer's seascape *The Gulf Stream* (page 73). Ruisdael showed the peace and quiet of the Dutch countryside during the 1600's. Homer showed the violence of the sea.

**Still lifes** are pictures of objects. Still-life painters usually make no attempt to tell a story or express an idea. Instead, they are interested in the objects themselves—their colour, shape, surface, and the space within or around them. Most still lifes show nonliving objects. The painting by Willem Claesz Heda on page 65 is a typical example. It shows in vivid detail objects that might be found in a Dutch home of the 1600's. Albrecht Dürer's *Young Hare* (page 33) is a still life even though it shows a living object. Dürer showed every detail of the animal, including individual hairs and whiskers. In this way, he gave the picture the frozen stillness that is a special feature of still lifes.

**History, mythology, and social expression.** Artists often find their subject matter in the past. They paint pictures that record real events or myths of long ago. Many such paintings are intended to recall past deeds of glory or to teach a lesson. Paolo Uccello's *The Battle of San Romano* (page 57) honours a military victory won by a city in Italy. Annibale Carracci's *Hercules at the Crossroads* (page 62) turned a Greek myth into a lesson that urges people to lead good lives.

Many artists have used paintings to express political and social beliefs and to protest against such things as war and poverty. Movements of social expression have appeared in painting throughout history. One such movement occurred in the United States during the mid-1900's. In some cases, black artists covered outdoor walls with paintings dealing with social issues. William Walker's *Wall of Love,* on this page, is an example.

**Painting compositions.** The way that painters arrange colours, forms, or lines is called *composition.* Some painters use no recognizable subject matter. Instead, they stress composition for its own sake. Piet Mondrian's *Lozenge Composition in a Square* (page 86) is an example.

Composition is also important in paintings that have recognizable subject matter. Tintoretto's *Saint Mark Rescuing a Slave* (page 34) is as important for its composition as for the story it tells. Tintoretto placed each figure perfectly to direct attention toward the floating figure of Saint Mark pointing to the slave on the ground. Viewers can enjoy the skilful composition even if they do not understand the story.

**Painting as decoration.** Many paintings have been created to decorate rooms or buildings. The subject matter of most of these paintings is less important than the painting's place within the total scheme of decoration. For example, the Kaisersaal, a room in a palace in Würzburg, Germany, has a number of outstanding paintings by Giovanni Battista Tiepolo. But these paintings, one of which is on page 34, are no more important than the windows, columns, or imitation draperies in the room. Many artists and artisans created these objects, and each object became a part of the room's overall decoration.

Paintings consist of many artistic elements. The most important elements include (1) colour, (2) line, (3) mass, (4) space, and (5) texture. These artistic elements are as important to a painter as words are to an author. By stressing certain elements, a painter can make a picture easier to understand or bring out some particular mood or theme. For example, an artist can combine certain colours and lines in a painting to produce an intensely emotional feeling. The same artistic elements can also be combined in a different way in order to produce a feeling of peace and relaxation.

Pablo Picasso probably became involved with more kinds and styles of painting than did any other artist of the 1900's. This section shows five paintings by Picasso. In each one, Picasso used all the major elements. But he emphasized one element in each picture to create a particular effect.

**Colour** can help an artist tell a story, express an emotion, or—as in Picasso's *Mandolin and Guitar*—create a composition. Picasso did not colour all his forms as they would appear in real life. Instead, he used strong primary colours—such as blue, red, and yellow—in the parts of the painting he wanted to emphasize. He balanced these colours with delicate black, brown, grey, tan, and white colours. The result is a pleasing composition created largely by the painter's skilful arrangement of colours.

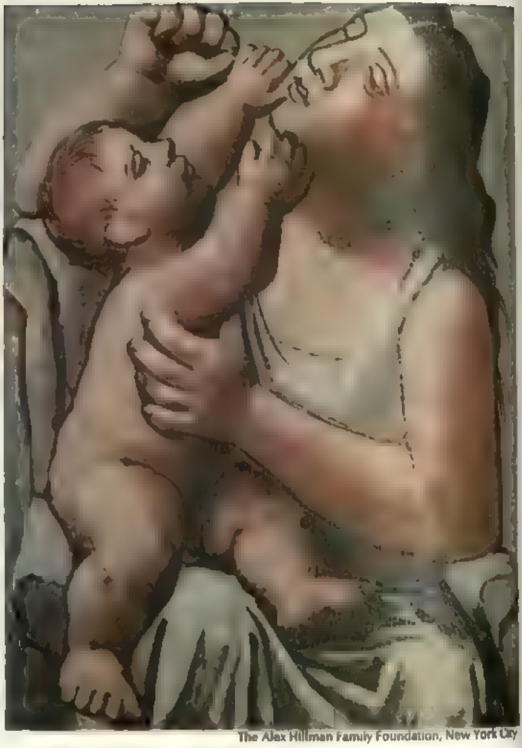
**Line** is the chief means by which most artists build up the forms in their pictures. By combining lines of different lengths and different directions, an artist makes a drawing. The addition of paint makes the drawing a painting.

In *Two Acrobats with Dog,* Picasso used lines to show the edges of his figures. Some lines are thick and some are thin. The artist emphasized line to make the viewer aware of the roundness of the forms and the delicacy of the slender figures of the young boys and the figure of the dog.

**Mass** allows an artist to express the feeling of weight in a painting. Picasso created *Mother and Child* largely in terms of mass. The bulky, solid appearance of the figures in the painting impresses the viewer. The artist made the figures look as if they are made of stone or some other heavy material. By stressing mass, Picasso made the figures seem like monuments that will last a long time.

**Space.** By arranging lines, colours, and light and dark areas in certain ways, painters can create an appearance of great space—even though they really paint on a small, flat surface. An artist can make an object look flat or solid, and either close or far away. In some paintings, space plays just as important a part as the solid forms. Picasso's *Seated Bather* shows a skilful use of space. The openings between the bonelike forms are just as expressive and interesting as the solid forms in the painting.

**Texture** refers to the appearance of the painting's surface. The paint of a picture may be thick and rough or thin and smooth. In *Woman Weeping,* Picasso created a rough texture by using thick strokes of paint. This texture adds to the painful emotional feeling of the painting.



The Alex Hillman Family Foundation, New York City

*Mother and Child* by Pablo Picasso
1921. Oil on canvas. 97 by 71 cm.

Mr and Mrs. William A. M. Burden, New York City

*Two Acrobats with Dog* by Pablo Picasso
1905. Gouache on cardboard. 105 by 75 cm.

The Solomon R. Guggenheim Museum Collection, New York City

*Mandolin and Guitar* by Pablo Picasso
1924. Oil and sand on canvas.
1.43 by 2.03 m.

The Museum of Modern Art, New York City. Mrs. Simon Guggenheim Fund

*Seated Bather* by Pablo Picasso
1930. Oil on canvas. 1.63 by 1.30 m.

Penrose Collection, London

*Woman Weeping* by Pablo Picasso
1937. Oil on canvas. 60 by 49 cm.


**Artists' paint** is made by mixing powdered colours called *pigments* with sticky substances called *binders*. The kind of paint produced depends on the binder used. This picture shows a pigment, some of the most common binders, and the kind of paint that is made with each binder.

## *Materials and techniques*

An artist makes a picture by spreading paint on a surface, such as a wall or a piece of fabric, paper, or wood. The appearance of the picture is affected by the surface on which it is painted, the kind of paint that is used, and the liquid that is used to thin the paint.

**Painting materials.** Paints are made by mixing dry powdered colours called *pigments* with sticky substances called *binders*. As the binder dries or hardens, it holds the pigment to the picture surface.

Early artists made their pigments from earth that had been coloured by mineral deposits. Artists still use many such natural pigments. But artists today also use pigments that are produced artificially by industrial processes.

Many kinds of binders are available to painters. One group of binders is made of vegetable gums, such as gum arabic, thinned with water. Other binders include vegetable oils, such as linseed oil, poppy seed oil, and walnut oil; beeswax; egg yolk; some kinds of glue; natural resins made from liquids in trees; and artificial resins made industrially. The binder used by an artist affects his work. For example, each binder causes a different amount of gloss and texture in the painting. Some binders dry quickly and others dry slowly. The binder an artist selects depends on the painting technique he uses. For example, linseed oil is used for oil painting and gum arabic is used for watercolours.

Artists use paint thinners (also called *painting mediums*) along with pigments and binders. An artist uses a thinner to get his paint to the liquid state he prefers. Watercolours require water as a thinner. Oil paints may be thinned with turpentine or a combination of oils, turpentine, and varnish.

Artists use brushes and painting knives to put paint on the picture surface. The best brushes are made by hand from high-grade raw materials, such as sable hair

or pig bristles. Brushes come in many lengths and shapes, allowing artists to produce various kinds of strokes.

**Painting supports.** The material that artists use as a foundation for their paintings is called the *support.* Walls were probably the earliest supports. Cave dwellers and other prehistoric peoples painted on stone walls. In ancient and medieval times, many artists painted on plastered walls.

As civilization developed, demands grew for paintings on a variety of other surfaces, including wooden altarpieces, coffins, and wedding chests; cloth banners; and books. To meet these demands, artists learned to paint on wood; such fabrics as cotton, linen, and silk; parchment; paper; and even metals and plastics.

*Wooden supports.* Artists in ancient Egypt painted on wooden mummy cases. Medieval artists painted on wooden panels that served as altarpieces. Artists during the Renaissance used panels for small pictures and furniture decorations. During the 1900's, many artists have painted on panels of *plywood* (thin layers of wood glued together). Plywood keeps its shape better than wood panels and can be obtained in large sizes. Today, a number of artists use wallboard panels, such as Masonite Presdwood. These panels are made industrially from wood fibres.

*Fabric supports* of various kinds have been used by painters since ancient times. Fabric is lighter than wood, and its lightness allows artists to paint large paintings that can be moved about. The cloth can be woven to any size the artist wishes. During the Renaissance, linen became the most popular fabric support. It remains so today. Other fabric supports used by artists today include cotton and jute. The fabrics artists paint on—regardless of the material—are often called *canvases.* The artist usually tacks the canvas to a wooden frame to keep it stretched evenly.

*Paper supports* have also been used since ancient times. Paper is the most widely used support for watercolour paintings. At least 5,000 years ago, Egyptians painted on paperlike material made from papyrus plant fibres. Before the A.D. 100's, Chinese artists used paper made from the bark of mulberry and bamboo trees. During the 800's, European artists began to use paper made from cotton or linen rags. Since that time, this kind of paper has been considered best for painting.

*Metal supports* include aluminium, copper, and iron sheets. Most painters do not use metal supports. Artists find it difficult to get paint to stick to metal without cracking or peeling.

*Plastic supports* are used by some modern artists. Plastics are available in colourless and tinted blocks and

**An artist's materials** include paint, paint thinners, and brushes and knives. The picture, *right,* shows how an artist might arrange these materials while making an oil painting. The dabs of colours on the palette were squeezed from the tubes. The artist has brushes of several sizes and shapes with which to make different kinds of brushstrokes. The liquid in the cups at the edge of the palette thins paint. The short knife, called the *palette knife,* is used to mix the colours. The longer *painting knife* is used, along with the brushes, to apply paint to a piece of fabric called a *canvas.* The canvas sits on an easel.

Detail of *An Epic of American Civilization* by José Clemente Orozco 1934 Baker Library, Dartmouth College, Hanover, N.H., courtesy of the Trustees, Dartmouth College

**Fresco painting** is the technique of applying paint onto damp, freshly laid plaster. Frescoes have been widely used to decorate walls of buildings, such as a library at Dartmouth College, New Hampshire, U.S.A., *above.*

in sheets that can be bent, carved, or sawed. Artists are experimenting with new ways to use these materials both as supports and for special effects in their pictures.

**Painting grounds.** Most support materials must be given one or more coats of a special kind of paintlike material called a *ground.* The ground reduces the roughness of the support and its ability to absorb liquid. Artists can apply paint more easily on a ground than on an untreated surface. Also, many grounds increase the brightness of pictures and help them stay bright.

Most painters use white grounds. But some artists prefer a ground tinted with a light colour. A tinting colour is called an *imprimatura.* The most common materials used for grounds are *glue gesso, oil priming,* and *acrylic gesso.*

Glue gesso is a paintlike mixture of white chalk, warm glue, and water. It is used most frequently on firm supports, such as wood panels. The artist paints several coats of glue gesso on the surface and rubs the last coat with sandpaper to produce a smooth, white surface.

Oil grounds are made of white pigment, such as lead white, and linseed oil thinned with turpentine. Oil grounds yellow slightly with age, but they are flexible. Artists use them on canvas to avoid the cracking that might result if the more brittle glue gesso were used on the flexible fabric.

Acrylic gesso is made of chalk and *acrylic resin,* a substance made from petroleum. It is used on both flexible and stiff supports. Acrylic gesso remains flexible and does not darken with age.

Detail of *The Creation of Adam* by Michelangelo. 1511. Sistine Chapel. The Vatican, Rome

**A fresco by Michelangelo** shows the smooth texture produced by this method. The plaster has cracked in places.

**Fresco painting** is a technique in which the artist paints on a plastered wall while the plaster is still damp. An artist who paints a wall picture on dry plaster uses a process called *secco painting.*

Fresco artists decorate both inside and outside walls. Their works contribute greatly to the beauty of buildings and homes. Fresco painting is especially well suited to decorating large walls in churches, government buildings, and palaces. A fresco, unlike many other types of paintings, has no glossy shine. A shine would make a fresco difficult to see from certain angles.

A wall must be carefully plastered before an artist paints a fresco on it. Usually, several layers of plaster are applied. The first layers are somewhat coarse. The final layer, called the *intonaco,* is smooth and bright white. The artist may plaster the wall, but most artists employ plasterers to do this work. The artist or plasterer does not apply the intonaco over the entire wall at once. Instead, the amount of intonaco that is applied is just enough for one day's painting. In many cases, platforms must be built so the artist can paint high sections of the wall or the ceiling.

It is difficult to make changes in the picture while painting in fresco. Therefore, the artist prepares for the work carefully. First, the artist works out the picture in colour sketches. Next, full-sized drawings, called *cartoons,* are made on heavy paper. Tracings made from these drawings are then hung on the wall. The artist produces outlines of the tracings on the surface of the final layer of plaster.

A fresco painter applies paint onto the wall while the plaster is still damp. The painter uses colours made of dry pigment that is mixed, in most cases, only with water. The plaster dries and hardens in about eight hours. The drying and hardening process seals the colours onto the wall.

The artist stops painting when the plaster is almost dry because the pigments—mixed only with water—will not stick to dry plaster. At the next working session, the artist gives the final coat of plaster to the area next to the part of the fresco that was finished previously. The artist then resumes painting, keeping the seam, or *join,* between the two sections as neat as possible.

Fresco plaster bleaches many colours. Therefore, not all pigments used in other painting techniques can be used in fresco painting. Fresco painters get the best results from soft, not too brilliant colours. These artists frequently use greys, rust tones, and tans. They use fewer strong blues, greens, reds, and yellows than do painters who work with other techniques.

Fresco painting reached its greatest popularity from the 1200's to the 1500's. Italy was the centre of fresco painting during that period. Leading fresco painters included Giotto, Andrea Mantegna, Masaccio, and Michelangelo. During the 1900's, Mexican artists revived fresco painting. They included José Clemente Orozco and Diego Rivera. Mexican artists decorated many public buildings with large frescoes that show scenes from Mexican history.

**Watercolour painting** can be done using two major techniques, (1) *transparent water colour* and (2) *gouache.* Transparent water colours are paints made of pigments combined with a gum arabic binder. An artist using this technique lightens the colours by adding water to them. In most other techniques, the artist adds white paint to lighten colours. The viewer can see the support through a layer of transparent watercolour. Gouache paint is also made with a gum arabic binder. But during the manufacturing process, a little white pigment or chalk is added to make the paint *opaque.* Opaque means that the viewer cannot see through a layer of the colour. An artist using the gouache technique makes the colours lighter by adding white paint to them.

Painters can buy watercolours as solid dry cakes that must be rubbed with a wet brush to produce paint. Artists can also buy watercolours in the form of moist paints packaged in tubes.

Watercolour painters use soft-hair brushes that hold a large amount of paint. These brushes help the artist make long lines and the *washes* that are typical of the watercolour technique. A wash is a broad, thin layer of colour applied by a continuous brush movement.

Watercolours dry more quickly than other paints. For this reason, the artist can rapidly paint one stroke over another in order to produce various colour effects. However, careless overpainting can make the picture look muddy.

Watercolour artists usually paint on paper. Many artists use watercolours on outdoor sketching trips because the equipment is light and compact and the paintings dry quickly. Artists also combine transparent watercolour with drawings. They brush transparent washes of colour onto a pen or pencil drawing. By using colour in this way, they can quickly and simply indicate relationships between different elements in the picture.

White paper is commonly used in the transparent technique. Artists who use the gouache method often paint on paper that has a brown or grey tone. When thinned with water and applied with a pointed brush, opaque paint can produce crisp, fine lines that show precise details. By using a wider brush and thicker paint, the artist can apply broader portions of paint to produce strong flat colour areas. Many artists have used opaque watercolours to decorate manuscripts and to paint highly detailed miniature pictures.

Most styles of modern transparent and gouache

*Off Stonington* by John Marin. 1921. Transparent watercolour. 42 by 50 cm. Columbus Museum of Art, Columbus, Ohio, U.S.A., Gift of Ferdinand Howald

Detail of *Trapeze Artist at the Medrano Circus* by Henri de Toulouse-Lautrec. 1893. Gouache on cardboard. Fogg Art Museum, Harvard University, Cambridge, Massachusetts, U.S.A. Bequest of Mrs. Annie Swan Coburn

**Watercolour painting** can be done using two major techniques, *transparent* and *gouache.* A viewer can see through a layer of transparent watercolour, *left,* but not through a layer of gouache, *right.*

watercolour painting grew out of techniques developed in England, France, and the Netherlands during the 1700's and 1800's. But watercolour paints had been used to decorate walls and ornamental objects in ancient Egypt and Asia, and in Europe during the Middle Ages.

**Encaustic painting** involves the use of melted wax as the binder. Pure beeswax is the best kind of wax for this purpose. The artist melts the wax in a container over a stove. A small amount of linseed oil or varnish is usually added to the melted wax. While the wax is in hot liquid form, the artist combines it with dry pigments on a hot metal palette. An electric hot plate furnishes the heat for the palette.

The artist applies the hot paint to a surface, such as a wood panel or Masonite, that has been prepared with a gesso ground. The paint hardens as soon as it cools. For this reason, the painter must use short brushstrokes, and the colours do not blend easily.

The artist's next step is the *burning-in* process. The picture is placed faceup on a table and the painted surface is warmed with a heating lamp or other appliance. The heat softens the wax paint, causing the brushstrokes to melt into each other and into the panel. The artist may also use heated metal knives and other tools to blend the brushstrokes. By controlling the burning-in process, the artist can obtain many effects of colour and texture. After the burning-in, the paint hardens into a waxy semigloss surface. The surface can be polished to a higher gloss if desired.

Encaustic painting was widely used in Greece as early as the 400's B.C. But by about A.D. 800, the technique had been abandoned. During the 1800's, artists attempted to use wax paints for outdoor murals. Some painters of the 1900's have used the technique for easel pictures.

**Pastels** are coloured chalk sticks. They are made of pigment and a small amount of weak adhesive, such as gum tragacanth. The adhesive keeps the pigment in stick form. As the artist moves the pastel over the picture surface, the colour rubs off onto the surface of the support. The most common supports for pastels are rag paper and cardboard.

Of all paints, pastels come nearest to the brilliance of the original dry pigment. They do so because they are not made with a liquid binder, which normally darkens paints. Because no binder holds the pigment to the ground, pastel colours rub off easily. To prevent this from happening, the artist sprays a solution of glue or resin called a *fixative* lightly over the picture.

Many artists who draw especially well like to work in pastel because they can use the stick like a pencil while producing brilliant effects of colour. Using pastels, artists can apply colours in broad flat areas or in crisp lines.

Two French artists of the 1700's, Jean Chardin and Maurice Quentin de La Tour, made excellent pastel portraits. Outstanding French artists of the 1800's, including Edouard Manet, Jean François Millet, and Pierre Auguste Renoir, often worked in pastel. They captured the visual effects of light and atmosphere in pure pastel colours. Edgar Degas, another French artist of the 1800's,

Portrait by an unknown Roman artist. A.D. 100's. Encaustic on wood. 44 by 18 cm. Museum of Fine Arts, Boston, Massachusetts, U.S.A.

**Encaustic paint** does not damage easily. This nearly 2,000-year-old encaustic painting remains fresh.

Detail of *At the Milliner's* by Edgar Degas. About 1882. Pastel on paper. The Museum of Modern Art, New York City, Gift of Mrs. David M. Levy

**Pastel paintings** are noted for their delicate colours. Artists use pastel in stick form, and stroke the colour directly onto the painting surface.

*Saint George and the Dragon* by Carlo Crivelli. 1470. Egg tempera on wood. 91 by 46 cm. The Isabella Stewart Gardner Museum, Boston, Massachusetts, U.S.A.

**Egg tempera paintings** have clear, sharp shapes and bright tones. The painting *Saint George and the Dragon,* reproduced in complete form and detail above, shows how an artist can use the egg tempera technique to paint a highly detailed scene.

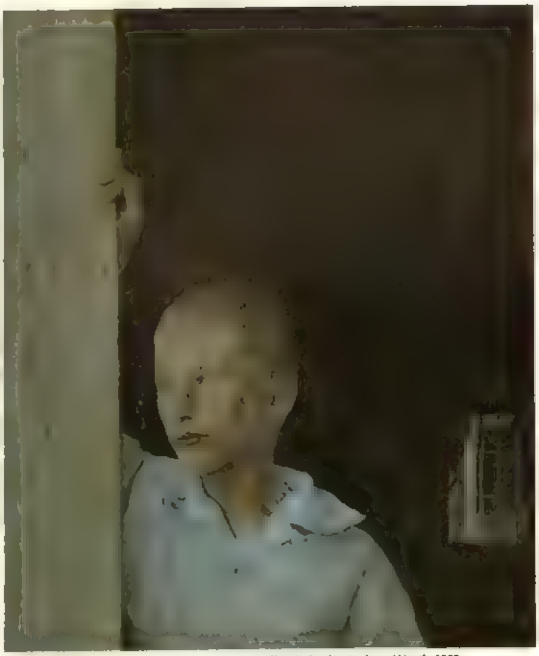
used pastels to make pictures of bathers, dancers, and people working. Degas's well drawn, brilliantly coloured works proved that pastel could be a major painting technique.

**Tempera** is sometimes used as a general term for opaque water colours, particularly the inexpensive paints called *poster paints.* However, the word *tempera* more specifically refers to a technique in which egg yolk is used as the binder. Most egg tempera paintings are done on wood or Masonite panels that are prepared with gesso grounds.

To prepare tempera, the artist first mixes dry pigments with a little water until the pigments resemble a stiff paste. Then an amount of fresh egg yolk equal to the amount of paste is added to the mixture. The tempera paint may be thinned with water to make it flow easily as the artist works.

A painter usually applies tempera in fine, crisp strokes with a pointed brush. The paint dries almost immediately into a thin, water-resistant coating. Tempera dries quickly, and so the brushstrokes do not blend easily. Normally, the artist develops the tones of the picture through a series of thin strokes laid over each other. This method resembles the way a drawing might be built up by using crisscrossing pen lines to represent different degrees of darkness. In a tempera painting, most shapes are sharp and clear. Tones are bright, and details are exact and strong.

An artist should not apply tempera paint too thickly because the paint cracks when applied in heavy layers.



*Albert's Son* by Andrew Wyeth. 1959. Egg tempera on Masonite. 74 by 62 cm. Nasjonalgalleriet, Oslo, Norway. © Andrew Wyeth

**A modern egg tempera painting** by Andrew Wyeth expresses a feeling of loneliness. The artist created this feeling by skilfully combining realistic details with areas of light and dark.

Tempera paintings require protection against dirt and scratching, and so the artist usually applies a coat of varnish to the finished picture.

The tempera technique achieved its greatest popularity between 1200 and 1500 in Europe. Beautiful tempera pictures were painted during the 1200's and 1300's in Siena, Italy, by Duccio di Buoninsegna and Simone Martini. Several modern artists have used tempera skilfully. They include the American painters Ben Shahn, Mark Tobey, and Andrew Wyeth; and the British painters David Tindle and Edward Wadsworth.

**Oil paint** is made by mixing powdered pigments with a binder of vegetable oil. Linseed oil is the most common binder. Artists buy oil paints in the form of thick pastes packaged in tubes. If an artist wants the paint to be more fluid, he or she adds a painting medium made of linseed oil, varnish, and turpentine.

Certain features of oil paint make it popular with artists who want to show the natural appearance of the world around them. Oil paint dries slowly. Therefore, the artist has time to blend the strokes into each other carefully and to adjust the colour mixtures to reproduce natural appearances. Oil paint—even when applied thickly—does not crack so easily as does water paint or egg tempera. As a result, the painter can apply oil paint in varying thicknesses to produce a wide range of textures.

Each artist develops his or her own method of working with oil paint. Many use some variation of the following steps. First, the artist puts on a wooden palette a small dab of each colour that will be used in the painting. The artist can mix colours on the palette to produce new tones. A small cup clipped to the corner of the palette holds paint thinner.

Usually, before beginning to paint, the artist draws the important outlines on the canvas or panel with charcoal or a pencil. Some artists attempt to achieve their final effects immediately. They paint all the colours and details in a few sessions or even at a single session. This method is called *direct painting* or *alla prima*. If an artist can use this method without making any corrections, the picture will appear lively, natural, and unified.

Another method, called *indirect painting,* allows the artist to paint a picture one step at a time. The artist can postpone some steps in painting the picture while concentrating on others. For example, the painter may not use full colour at the beginning of the work. Instead, the artist may use only grey and white paint to develop the pattern and drawing of the picture. After this has been done, the picture is allowed to dry. The artist can then add the colours to produce a full-colour painting.

All oil paintings require a final coat of removable clear picture varnish for protection against dirt and rough handling. The varnish is applied after the painting has dried for at least six months. As the varnish ages, it becomes dirty and brown, darkening the picture and changing its tones. When this happens, the old varnish should be removed and a new coat applied so the artist's original colours can be seen again.

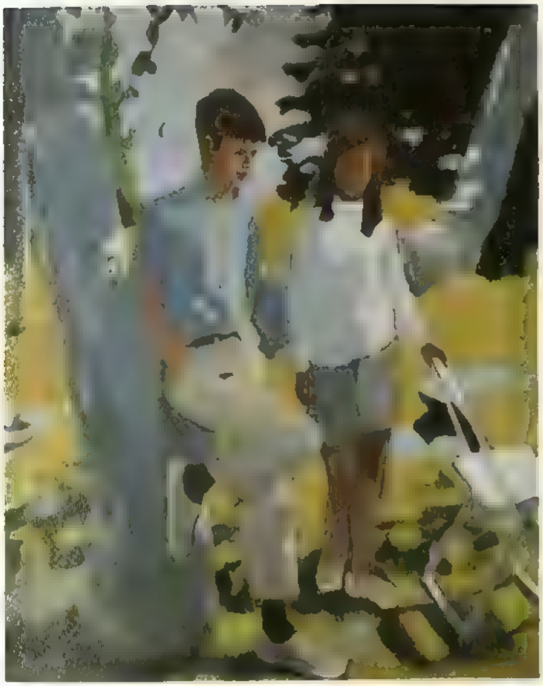
Oil painting first became popular in Europe during

Detail of *Man with a Magnifying Glass* by Rembrandt. About 1658. Oil on canvas. The Metropolitan Museum of Art, New York City, Bequest of Benjamin Altman, 1913



Detail of *The Postman Roulin* by Vincent van Gogh. 1888. Oil on canvas. Museum of Fine Arts, Boston, Massachusetts, U.S.A.

**Oil paintings** can be made by the *indirect* method or the *direct* method. Using the indirect method, *left,* Rembrandt painted in steps, smoothly brushing one colour over another. Using the direct method, *right,* van Gogh painted rapidly, allowing individual brushstrokes to stand out.



*Portrait of Stephen and Kathie* by Fairfield Porter, 1963. Acrylic on canvas. 1.52 by 1.22 m. Knoedler Gallery, New York City

**Acrylic paint** permits artists to produce many colour effects. The painting by Fairfield Porter, *above*, emphasizes flat colours. The paintings by Morris Louis, *upper right*, and Helen Frankenthaler, *right*, consist of colours that seem to glow on the canvases.

*Blue Veil* by Morris Louis. About 1959. Acrylic on canvas. 2.55 by 3.78 m. Fogg Art Museum, Harvard University, Cambridge, Massachusetts, U.S.A. Gift of Mrs. Culver Orswell and Gifts for Special Uses Fund

*Pre-Dawn* by Helen Frankenthaler 1965. Acrylic on canvas. 1.92 by 1.42 m. Collection of Mr and Mrs. Michael B. Magloff, Beverly Hills, California, U.S.A.

the 1500's. By the 1700's, it had become the most common painting technique. It remains the technique preferred by many artists today.

**Synthetic resins.** Over the years, manufacturers have made many improvements in the quality of artists' paints by developing better pigments. But until 1946, little was done to improve the materials used as binders. Since then, manufacturers have developed many artificial resins for use as binders. These resins are made industrially from such materials as coal or petroleum. Tests seem to indicate that some resins are stronger, more flexible, and more water resistant than such traditional binders as egg yolk, glue, and gum arabic. Also, these resins do not darken as they age.

Today, artists most frequently use two synthetic resins—acrylic and vinyl. Acrylic and vinyl paints can be used on a wide variety of surfaces, including cardboard, paper, fabrics, and wood. Colours can be painted over each other rapidly because they dry and form a waterproof surface almost immediately.

An artist using acrylic or vinyl paints can produce effects that closely resemble the effects of egg tempera, fresco, or oil paints. The painter can also produce effects that cannot be produced with traditional painting materials. For example, experimenting artists have found that they can create thick, almost sculptural layers of paint as well as thin transparent washes. They can make smooth surfaces as well as extremely rough textures. Heavy coatings of transparent colour can even be made to resemble stained glass. Artists probably will give resins a place along with oil paints and water paints among their materials.

*San Clemente* by Karl Zerbe. 1952. Polymer tempera. 76 by 61 cm. Joseph Hirshhorn Collection, New York City

**Vinyl paints** include polymer tempera, *above*, an industrially made substitute for egg tempera.

Tomb of Nakht, Thebes, Egypt (c Carlo Bevilacqua)

*Grape Harvest* by an unknown Egyptian artist
About 1425 B.C. Fresco. About 31 cm high.

## Origins and early painting

**Prehistoric painting.** No one knows when people first painted pictures. Paintings from prehistoric times have been discovered in many widely separated places. Scholars date the oldest known paintings at about 20,000 B.C. The high quality of these works suggests that people began to paint pictures much earlier.

Many of the finest prehistoric paintings have been found in caves along the border between France and Spain. Most are realistic portrayals of animals. Some also show hunters. A reproduction of a painting from the Lascaux Cave in France appears on page 31.

No one knows why people began to paint. Perhaps people believed the ability to make likenesses of human beings and animals gave them special powers. They may have felt these powers enabled them to communicate with their gods, made them better hunters, or gave them the strength of the animals they hunted.

**Egyptian painting.** The ancient Egyptians began painting about 5,000 years ago. They developed one of the first definite traditions in the history of the art.

Egyptian artists painted on the walls of temples and palaces, but much of their finest work appears in tombs. Like other early peoples, the Egyptians believed that art was a magical way of transporting things of this world into a world people entered after death. Egyptian artists decorated tombs with frescoes showing people and objects related to the life of the dead. Some scholars believe the Egyptians wanted to be certain that the gods understood the frescoes so that the dead would regain their possessions in the next world. This could explain why Egyptian artists painted according to strict rules that hardly changed for thousands of years. The figures they drew look stiff. The heads of people in the paintings always face sideways. The shoulders and body face to the front, and the feet point to the side. Important people are larger than the other people.

Artists painted tombs only for the benefit of the gods and the souls of the dead. The tombs were sealed and the beautifully coloured frescoes were intended never again to be seen. The picture on this page shows part of a fresco from the tomb of Nakht, an Egyptian nobleman.

**Cretan painting.** About 3000 B.C.—while Egyptian civilization was flourishing—another great civilization was developing on the island of Crete. The Cretans, a seafaring people, often came into contact with the Egyptians. The Cretans adopted some elements of Egyptian art, including the Egyptian way of drawing human figures. But the Cretan style did not have the stiffness of the Egyptian style. Cretan paintings are lively, and the figures in them seem to float and dance. More importantly, Cretan painters, unlike the Egyptians, were interested in life in this world. They used paintings to decorate buildings instead of concealing the paintings in tombs. Thus, Cretan art became a bridge between Egyptian art, which emphasized death, and ancient Greek and Roman art, which dealt with life. The lively fresco on page 47 decorated a Cretan palace.

**Greek painting.** The ancient Greeks made greater achievements in architecture and sculpture than in painting. Nearly all surviving Greek paintings appear on pottery. The Greeks made beautifully shaped pottery and painted it with scenes from everyday life and from stories about their gods and heroes.

Greek artists of the late 600's and the 500's B.C.

Reconstruction from the palace of Minos, Knossos, Crete, Greece

Queen's Room
by an unknown Cretan artist
About 1500 B.C. Fresco. Dolphins about 91 cm long.

Pompeii, Italy

*The Punishment of Ixion,* House of the Vettii
by an unknown Roman artist
About A.D. 79. Fresco. Figures about one-third life size.

painted black figures on naturally red pottery. This method became known as the *black figure style.* A painter named Exekias was a master of the style. The painted vase shown on this page is typical of his work. It shows Achilles and Ajax, the Trojan War heroes, dressed in armour and playing a game resembling dice.

Beginning about 530 B.C., Greek artists developed the *red figure style,* the reverse of the black figure style. These artists painted the background of their pottery in black and let natural red show through to form the figures. The red figure painters, like the Greek sculptors of the same period, created extremely lifelike figures. This "ideal style" became the chief quality of the so-called classical art of the Greeks and Romans.

**Roman painting.** Scholars know more about Roman painting than Greek painting because a wider selection of Roman paintings has survived. Roman artists were strongly influenced by the Greeks. Therefore, Roman painting gives us an idea of what the lost paintings of the Greeks were like.

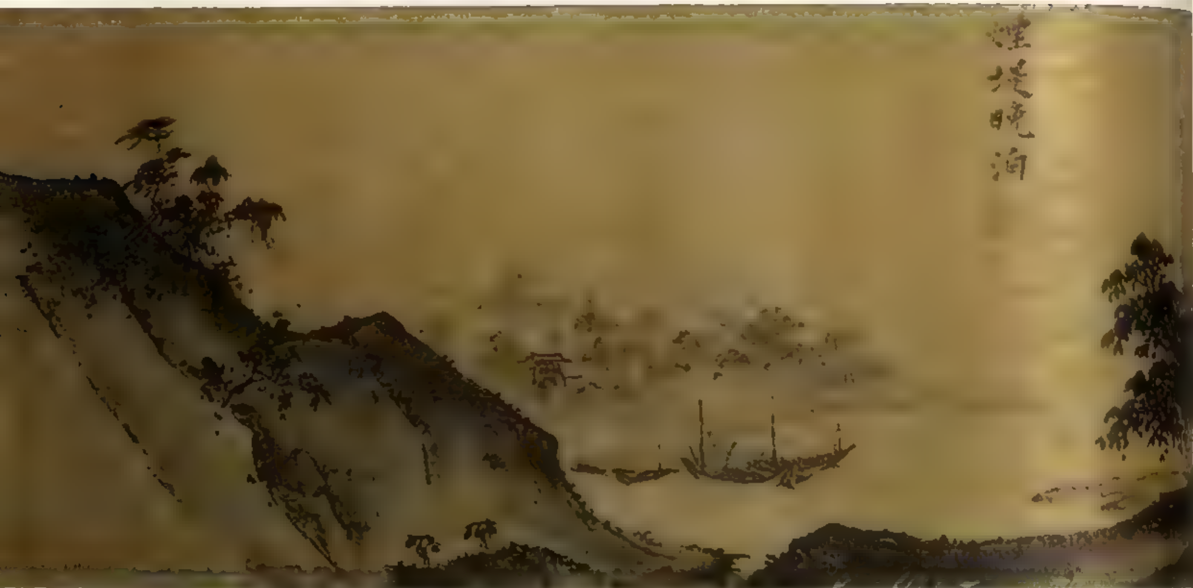
Roman artists gave the figures in their pictures the same lifelike quality found in classical Greek and Roman sculpture. Roman artists added to the reality of their works by painting convincing illusions of depth, shade, shadow, and reflected light. Creating an illusion of depth is called *drawing in perspective.* The Romans were among the first to develop this important skill.

Some of the best examples of Roman painting have been found in the ruins of the city of Pompeii. The house of two brothers named Vettius contains frescoes portraying stories about Ixion, a mythical hero. These frescoes consist of elaborately designed painted panels, one of which is shown on this page.

The Vatican Museums, Rome

*Achilles and Ajax Playing Dice* by Exekias
About 530 B.C. Vase about 61 cm high.

# *Oriental painting*



Nelson Gallery-Atkins Museum, Kansas City, Missouri U.S.A., Nelson Fund

Detail of *Twelve Views from a Thatched Cottage* by Xia Gui
About 1200. Ink painting on a silk hand scroll. 28 cm high.

The Metropolitan Museum of Art, New York City, Harris Brisbane Dick Fund, 1934

*The Infant Zal Presented to His Father*
by an unknown Persian artist
Mid-1500's. Gouache on paper. 45 by 31 cm.

Oriental painting, the painting of Asia, has three main branches—Indian, Chinese, and Islamic. Indian painting includes the art of India, Burma, Cambodia, Indonesia, Nepal, Sri Lanka, Thailand, and Tibet. Chinese painting includes the art of China, Japan, and Korea. Islamic painting is the art of the Muslims, followers of the prophet Muhammad. They originally lived in southwest Asia. During the A.D. 700's and 800's, they spread to North Africa and many parts of Asia, including northern India. The most important centre of Islamic painting was Persia (now Iran).

**Indian painting** is primarily religious art. Indian painters create their works to help the people communicate with their gods. Their main subjects include gods and stories about the gods and holy people. Indian artists paint on manuscripts of holy texts, on banners and wallhangings, and on walls.

Indian painting deals with several religions, including Buddhism, Hinduism, and Jainism. Buddhism, the most widespread of these faiths, began in India as a unified religion. It developed many *sects* (groups) as it spread throughout eastern Asia. Each sect had its own rituals and religious practices.

Artists in all the Buddhist sects painted works with religious themes, and they also added elements of local beliefs. For example, a Buddhist sect called Lamaism arose in Tibet in about A.D. 650. Lamaist painters combined the Indian emphasis on religion with the native Tibetan belief in demons and spirits. As a result, many Tibetan paintings are religious works filled with fantastic and grotesque figures. The painting of the god Raktayamari on page 49 is an example. The artist included nothing in the painting simply for decoration. He directed all the elements of this picture toward increasing the reli-

gious experience of the viewer. Every object and figure in the painting has a specific meaning. Raktayamari is the central god, and he is surrounded by many lesser gods. He is portrayed as red and fierce in order to show his great power. Raktayamari's many arms let him display all the symbols of his power at once. The god appears warlike and full of motion, which shows that he can conquer his enemies.

The artist did not attempt to show Raktayamari and the other figures in real space. All the figures seem to float in a heavenly atmosphere. They are seated on clouds or lotus plants. Clouds and a ring of flame—which symbolize the universe—encircle the chief figure and fill the background with swirling movement and colour.

**Chinese painting.** Painting became an art form in China more than 2,000 years ago. Many scholars consider the Song dynasty (A.D. 960-1279) as the classic period of Chinese painting. The works of that period strongly influenced later Chinese painting.

Chinese painters learned their art by copying master painters of the Song and other past periods, rather than by studying nature. This emphasis on tradition led to many established forms and styles that Chinese artists used in various combinations to express ideas and moods. The great Chinese painting tradition ended in the 1900's.

The major Chinese religions all stressed a love of nature. Partly as a result, three major kinds of subject matter dominate Chinese painting. They are birds and flowers; figures; and landscapes of the countryside, mountains, and sea. Chinese landscape painters tried to create a feeling of union between the human spirit and the energy of the wind, water, mist, and mountains. Such pictures express the Chinese belief that there is an inner harmony and balance among all things in the world.

Chinese painting is closely related to the art of fine handwriting called *calligraphy*. Like calligraphers, Chinese painters used black ink that could produce different tones and a brush that could make many kinds of lines. Artists created many paintings in black ink only. Even when they added colour, the ink drawing remained the basis of the design. In judging paintings, the Chinese paid more attention to the brushstrokes than to the subject matter.

Most surviving Chinese paintings are painted on silk or on absorbent paper. Some paintings were on scrolls that were normally rolled up. Some were meant to be placed in albums. Others were created to be mounted on fans. Many artists painted on walls or on large screens. All these paintings require careful study. The artists intended their works to be examined only if the viewer had time to enjoy them without distraction.

In China, painters, like poets and scholars, were considered persons of learning and wisdom. Chinese paintings were closely associated with poetry. Many Chinese paintings combine certain objects, such as a particular bird and flower, because the objects are associated with a famous poem.

Chinese painters produced many great landscapes painted on long scrolls. The viewer unrolls the scrolls slowly from right to left, revealing a continuous succession of scenes of the countryside. The viewer unrolls the scroll with the left hand and rerolls the part already seen with the right hand. Only a small section of the painting

Museum of Fine Arts, Boston, Massachusetts, U.S.A. Gift of John Goelet

*Raktayamari, Red Form of Yamantaka*
by an unknown Tibetan artist
1500's. Gouache on cotton. 82 by 72 cm.

Museum of Fine Arts, Boston, Massachusetts, U.S.A. Fenollosa-Weld Collection

Detail of *The Burning of the Sanjo Palace*
by an unknown Japanese artist
Late 1200's. Ink painting on a paper hand scroll. 41 cm high.

is visible at one time. These hand scrolls are a uniquely Chinese art form. Appreciation of them requires much patience and thought.

The detail of the painting *Twelve Views from a Thatched Cottage* (page 48) by Xia Gui (also spelled Hsia Kuei) is part of a long hand scroll. The painting continues without a break, but titles written on the painting identify the various parts. The artist painted his scenes with few brushstrokes. One stroke created a leaf on a tree. An unbroken line and a soft ink wash created a range of mountains. A few brushstrokes around the boats suggest an entire lake.

Xia Gui and Ma Yuan, another artist of the same period, created a style of idealized landscapes that greatly influenced Chinese and Japanese painting. Known as the Ma-Xia style, it is the kind of Chinese painting most familiar to people in the West.

Human figures were also important in Chinese painting. Artists painted portraits of both real and imaginary people. They painted scenes that illustrate stories and historical subjects. Many paintings show the elegant, refined life at court. Some of these pictures show furniture and decorations in great detail. Others have a plain background.

*Palace Ladies Bathing and Dressing Children* (page 51) provides a glimpse of Chinese court life in the 1100's or 1200's. In this painting, a child who wants to avoid taking a bath clings to his mother. The boy in the bath has his nose held to prevent water from entering it. Another woman undresses a boy. The artist painted the picture with a delicacy of line and colour that was appreciated by the people of that time.

**Japanese painting** is included in the tradition of Chinese painting because Japan's art was greatly influenced by China's. However, the Japanese changed the Chinese styles to suit their own taste.

The Japanese first came into contact with the Chinese during the A.D. 500's, when Chinese Buddhism was introduced into Japan. The Japanese believed that China's civilization was superior to their own. They tried to raise their own culture to the level of China's. Because the Japanese adopted the Chinese writing system, they developed the feeling for the expressive use of line found in Chinese ink painting.

Buddhism became a strong influence on Japanese culture. Artists painted Buddhist subjects on the walls of temples, on scrolls, and on panels of screens. Even nonreligious painting in Japan was influenced by Buddhism. At first, the Japanese painters imitated Chinese models. But by the 1100's, the Japanese use of colour and abstract design had transformed the art into a new form of expression.

From the 800's to the 1300's, a highly developed culture existed at the court of the Japanese emperor in the city of Kyoto. Paintings of this period show the refinement and delicacy associated with the nobility as well as the rough humour and violence of people outside the court. A set of scrolls called the *Heiji Scrolls* was painted during this time. Although the hand scroll form was borrowed from Chinese art, the painter's style is unrelated to Chinese scroll painting. The style is known as *Yamato-e* (Japanese painting) to distinguish it from Chinese-inspired scroll painting, called *Kara-e* (Chinese painting).

Japanese artists were interested in the time and place in which they lived. For example, *The Burning of the Sanjo Palace* (page 49), a scene from the Heiji Scrolls, shows a fierce battle between rival families of warriors. The painting deals with an event that took place shortly before the artist was born. It also shows the Japanese fondness for storytelling as well as for art that appeals to the emotions and the senses.

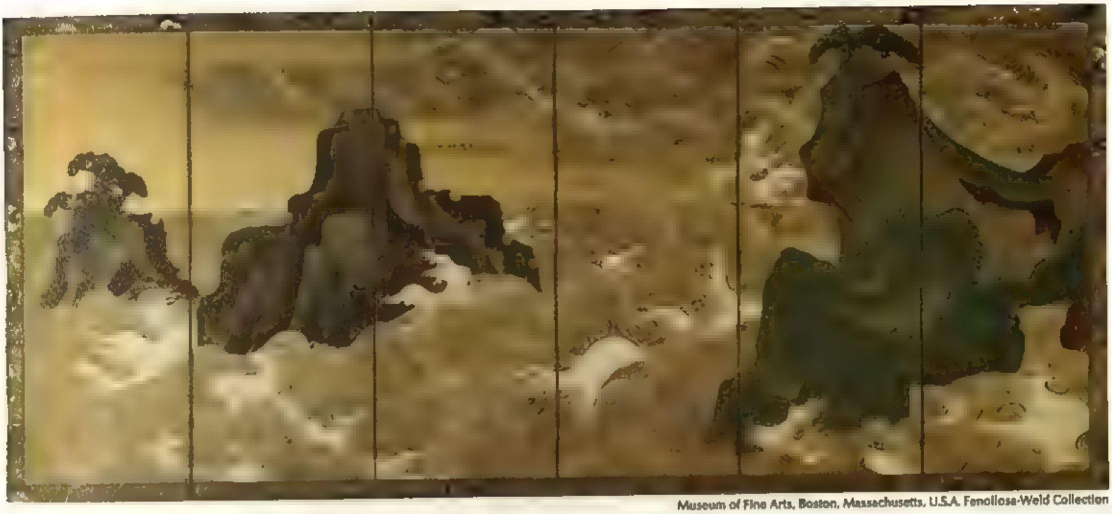
From the 1500's to the 1800's, Japanese artists painted in a style that strongly emphasized colour and design. These artists were called *decorators*. The decorators omitted detail from their pictures and stressed only outlines. They applied their colours evenly with no shading. The decorators often added gold leaf to their paintings for an effect of luxury. Decorative art was created for wealthy merchants and warriors, who liked the rich, colourful style.

The finest decorative paintings were pictures of nature, particularly animals, flowers, and landscapes. Compare the landscape *Matsushima* (page 51) by the Japanese artist Korin with the Chinese landscape on page 48. The Chinese artist transformed his landscape into an imaginary world of peaceful thought. Korin used bold colours and gave his landscape an abstract design by painting simplified shapes of rocks, pine trees, waves, and clouds.

Throughout most of its history, Japanese painting has reflected the taste of the upper classes. But the Japanese style most familiar in the West is an art of the common people. This style is called *ukiyo-e* (the floating world). It flourished from the mid-1600's to the mid-1800's. The floating world is a world of pleasure and entertainment, and of great actors and beautiful women. The bold sense of design typical of ukiyo-e can be seen in the woodcut reproduced in colour in the **Drama** (Asian drama) article.

**Islamic painting** is primarily the creation of beautiful books through calligraphy and illustration. Calligraphers copied texts in elegant handwriting, and artists added illustrations to increase the beauty of the books. Calligraphers copied the text of the Quran, the Islamic holy book, on pages that were then covered with gold leaf. Early Islamic artists decorated the pages with complicated patterns because their religion prohibited the making of images of human beings and animals. However, as time passed, many Islamic artists—especially those living in Persia—began painting human and animal figures.

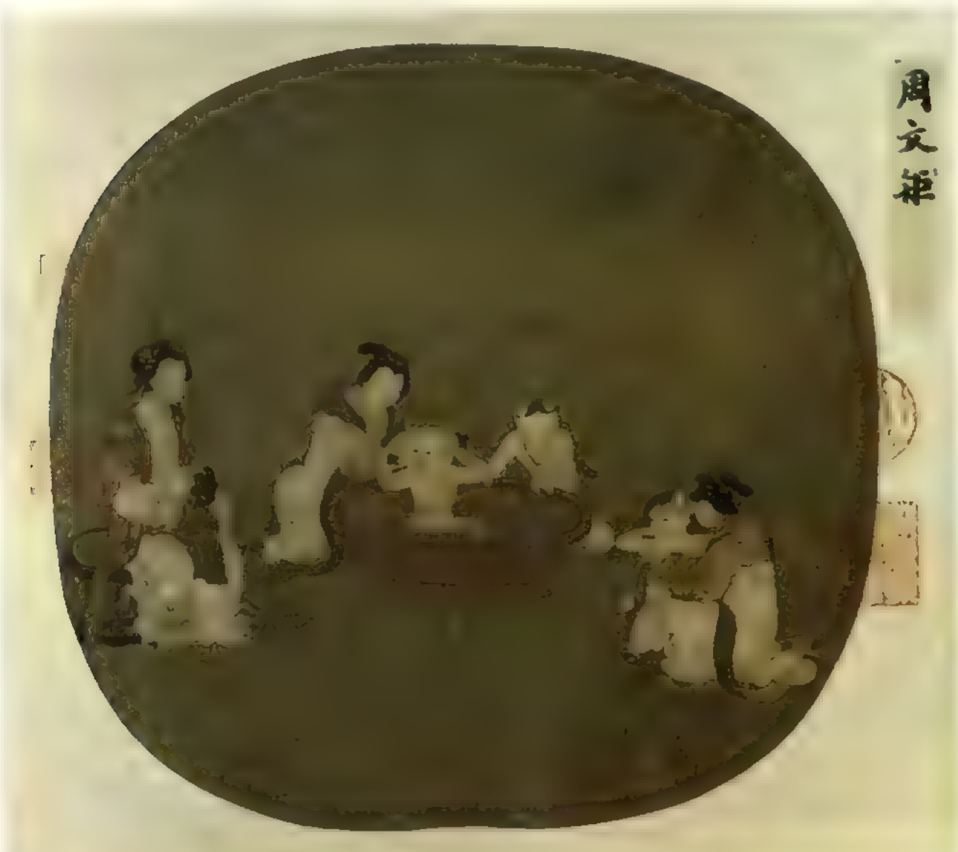
In addition to the Quran, Persian artists illustrated collections of fables, histories, love poems, and scientific works. The miniature *The Infant Zal Presented to His Father* (page 48) is an illustration from the *Book of Kings*, an epic poem that describes the legendary adventures of the early heroes of Persia. The miniature has jewel-like colour, the most important element in Islamic painting. The artist raised the background so the viewer could see every part of the scene clearly. The artist did not try to portray the real world, but instead tried to create a luxurious, ideal setting to delight the eye and stimulate the imagination.



Museum of Fine Arts, Boston, Massachusetts, U.S.A. Fenollosa-Weld Collection

*Matsushima* by Korin

Early 1700's. Ink painting on a six-panel paper screen. 1.55 by 3.77 m.




Freer Gallery of Art, Washington, D.C.

*Palace Ladies Bathing and Dressing Children* by an unknown Chinese artist

A.D. 1100's-1200's. Painted on a silk fan. 23 by 24 cm.

# Medieval painting

Medieval painting refers to most of the art produced in Europe during a period of about 1,000 years. This period began with the fall of the Roman Empire in the A.D. 300's and 400's and ended with the beginning of the Renaissance in the 1300's. Medieval European society centred on Christianity. Most medieval Christians believed that life on earth was less important than the life of the spirit. They placed the greatest importance on life after death. Painting in the medieval period reflected this attitude.

For medieval artists, the Christian religion—not human beings and nature—was the chief source of subject matter. These artists were not interested in techniques that would help show the world as it was. They generally ignored perspective and gave their works a flat look. They made wide use of symbols in their works in order to tell stories. For example, some medieval artists painted skies in gold or purple to symbolize God's kingdom in heaven.

Even though almost all medieval artists dealt with religious subjects, they developed several styles. One of these styles, called Byzantine, became the most important tradition among Christian artists of eastern Europe and the Near East. In western Europe, Celtic, Romanesque, and Gothic were the most important styles. In the late 1200's, an Italian artist named Giotto developed a realistic style that marked the end of the medieval period in art history and the beginning of the Renaissance.

National Gallery of Art, Washington, D.C., Andrew W. Mellon Collection

*Enthroned Madonna and Child*
by an unknown Byzantine artist
1200's. Paint and gold leaf on wood.
82 by 49 cm.

**Byzantine painting.** Starting in the A.D. 300's, eastern Christians gradually separated from the western Christians, who were ruled by the pope in Rome. Eastern Christian art is called *Byzantine* because the religion was based in the city of Byzantium (now Istanbul, Turkey). By the 500's, the Byzantine artists had developed a special style of religious painting. The Byzantine painting style has remained largely unchanged to the present day.

The painting *Enthroned Madonna and Child* on this page illustrates the Byzantine style. Like all Byzantine pictures, it portrays colourful but unlifelike figures that stand for religious ideas rather than flesh-and-blood people. The figure of the Virgin Mary is a beautiful, complex design in gold lines rather than a representation of a living person. The blue of the Madonna's robe symbolizes her royalty as the queen of heaven. The red of her cloak means she will suffer when Jesus is crucified. The gold in the background symbolizes God's universe. The baby Jesus is not a baby at all but a miniature man who is blessing the world.

**Celtic painting** developed among the tribes of Ireland and other parts of northern Europe. Celtic artists became most famous for their *illuminations* (illustrations) for Bibles. The Celtic style emphasized abstract patterns of elaborately arranged interlaced lines. An example from the famous *Book of Kells,* made in Ireland during the 700's or 800's, is reproduced in colour in the **Manuscript** article.

Schools of illumination arose in courts and monasteries throughout Europe. The Carolingian School was perhaps the most important one. It flourished in the 800's, during the reign of the famous emperor Charlemagne. See **Carolingian art.**

**Romanesque painting.** During the 1000's and 1100's, a generally uniform style of painting called *Romanesque painting* appeared in western Europe. Romanesque painting combined elements of classical Roman, early Christian, Byzantine, and Carolingian art. It developed at about the same time that many churches were being built to serve the needs of the growing Christian faith. Romanesque artists painted beautiful frescoes on the stone walls of many churches. The paintings lack perspective, but they show skill in composition. Some of the paintings look like brightly coloured pages from illuminated Bibles that had been enlarged and transferred to wall surfaces.

**Gothic painting.** During the 1200's, Gothic architecture replaced Romanesque as the style for many European churches. The Gothic style of architecture featured large windows that took away much of the wall space on which artists had painted frescoes in Romanesque churches. Artists filled the windows with beautifully coloured stained glass that told religious stories. In northern Europe, fresco painting declined during the Gothic period. Many painters during this time worked as illuminators. They decorated expensive manuscript copies of the Gospels and prayer books.

The colours and design of stained-glass windows influenced the Gothic manuscript painters. Many of these artists favoured the bright blues and reds common in stained-glass. They often divided their figures into

Scrovegni, or Arena, Chapel, Padua, Italy

*The Lamentation of Christ* by Giotto
About 1305. Fresco. 1.96 by 2.10 m.

separate compartments that resemble the many panels of these complex windows.

**Giotto.** Sometime during the 1200's, European painting took a turn toward greater realism. Some artists began painting people and scenes in a way that resembled their appearance in real life. This movement became strongest during the late 1200's in Italy. It is most apparent in the works of Giotto, one of the greatest painters in the history of art.

Gothic architecture was not widespread in Italy during Giotto's time. Giotto and other artists continued to paint frescoes on church walls. The Italians tried to make their church walls look like windows by decorating them with realistic frescoes.

Giotto's *The Lamentation of Christ,* reproduced on this page, illustrates both the trend toward realism and the amazing genius of this artist. Giotto painted the background a shade of blue that resembles the natural sky. The frame of the picture seems like the frame of a real window. The figures are three-dimensional—almost as if they were sculptured—and the angels seem to fly toward the viewer. The facial expressions of the figures vividly portray deep sorrow. Thus, Giotto gave the viewer a clear, powerful picture of how the Virgin Mary and the other mourners must have felt when Jesus was crucified.

Giotto combined good composition with realism in the fresco. The shapes of the figures in the bottom foreground are skilfully balanced with the shapes of the angels in the upper background. The diagonal form of the mountain directs the viewer's eye down to the heads of Jesus and Mary.

# The Renaissance

Beginning about 1400, European painting flourished as never before. This era of great painting took place during the period of history called the Renaissance. The Renaissance began in Italy in about 1300 and spread northward. By 1600, it had affected nearly all of Europe.

One very important aspect of the Renaissance was a great revival of interest in the arts and literature of ancient Rome. This revival had an enormous influence on painting. Religious subject matter remained important. But artists began to paint figures based on lifelike ancient Roman statues. Many artists included elements of Roman architecture in their pictures. The Italian city of Florence and the northern European region of Flanders became the major centres of painting in the early Renaissance.

### The Renaissance in Florence

The first important Florentine painters appeared during the 1420's. They adopted Giotto's idea that a picture should be like a window to the real world. These artists were especially interested in how they could apply principles of geometry to painting so their pictures would resemble real life.

**Early works.** Gentile da Fabriano was a pioneer in the development of the Florentine Renaissance style. His work forms a link between medieval and Renaissance painting. In *Adoration of the Magi* (page 55), Gentile followed the medieval tradition of using gold leaf in order to make the picture as decorative as possible. However, he departed from medieval tradition by giving the painting a feeling of spaciousness and natural-looking light. Gentile added to the picture's impression of reality by including many informal details. In the centre foreground, for example, a servant is removing the spurs from his master's feet.

Gentile's *Adoration* appeared in 1423 and became a major influence on Florentine art. A few years later, a Florentine artist named Masaccio painted a series of frescoes that had even greater influence than Gentile's work. Before beginning the frescoes, Masaccio learned the technique of *linear perspective* from the architect Filippo Brunelleschi. An artist using linear perspective imitates reality by making objects look smaller as they get farther away from the viewer.

Masaccio's fresco *The Tribute Money,* shown below Gentile's painting, uses linear perspective. It gives a more correct relationship between near and far objects than do the picture by Gentile and other earlier works. Masaccio also used *atmospheric perspective* in a more advanced way than did earlier artists. Atmospheric perspective is the impression that objects in the distance appear more fuzzy and bluish than when seen from close by.

Masaccio's figures are much more solid looking than Gentile's. Masaccio created a sculptural effect through the skilful use of light and shadow. This sculptural quality set the style for painting of figures in Italy throughout the Renaissance.

During the 1430's, Leon Battista Alberti wrote a book about painting that influenced artists for hundreds of years. In this book, Alberti declared that a picture should tell a moral and noble story, preferably from ancient history, the Bible, or mythology. The figures should be grand and handsome and should suggest a feeling of self-control. Alberti believed that such subject matter and style would teach people how to live more civilized lives.

**Florentine masters.** The Renaissance in Florence produced many great painters. One of them was a Dominican monk called Fra Angelico. His works show the influence of the ideas of Masaccio and Alberti. The fresco *The Annunciation,* on this page, ranks among Fra Angelico's most famous paintings. It shows the angel Gabriel telling the Virgin Mary that she will become the mother of Jesus. The two are meeting in an arcade similar to an actual arcade in the courtyard of a monastery.

San Marco Museum, Florence, Italy

*The Annunciation*
by Fra Angelico
About 1450. Fresco.
2.3 by 3.21 m.

Uffizi Gallery, Florence, Italy

*Adoration of the Magi* by Gentile da Fabriano
1423. Egg tempera on wood. 3 by 2.82 m.

*The Tribute Money* by Masaccio
About 1427. Fresco. 2.55 by 5.98 m.
Santa Maria del Carmine Church, Florence, Italy

Ducal Palace, Mantua, Italy

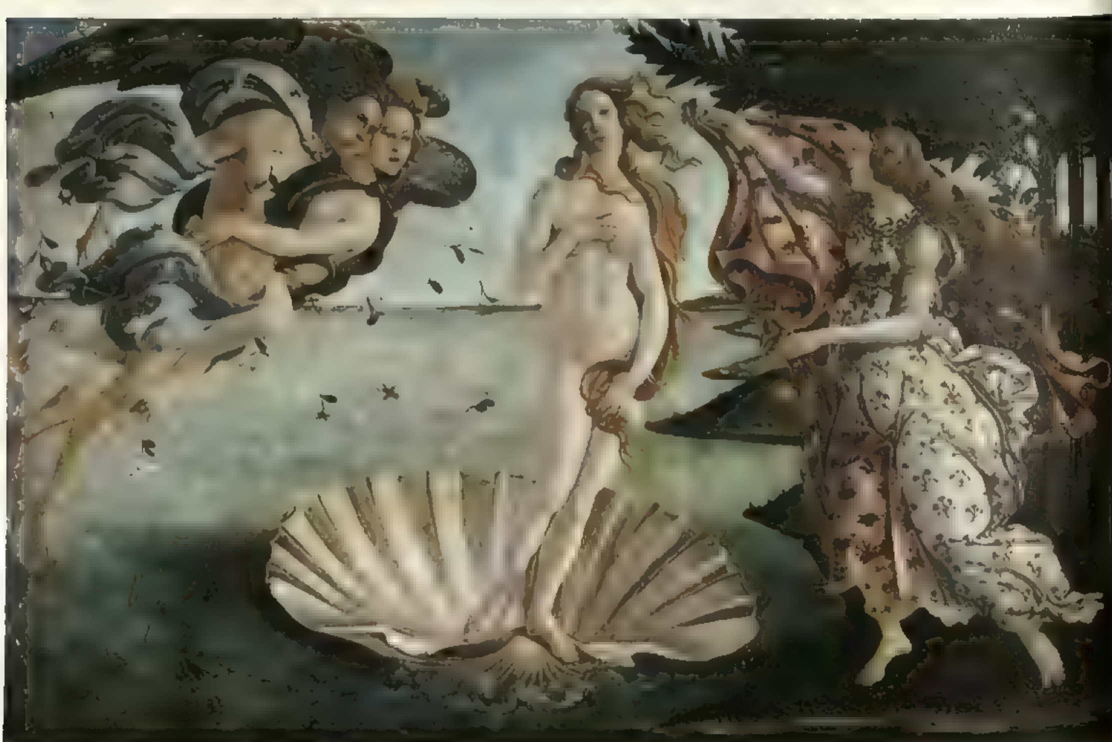
Detail of *Family and Court of Ludovico Gonzaga II* by Andrea Mantegna
1474. Fresco and other media. Figures larger than life size.

Fra Angelico painted the architecture in the ancient Roman style. He emphasized linear perspective, and his use of light and shadow makes the figures look as firm as architectural columns.

Andrea Mantegna, a painter who lived in Padua, was strongly influenced by the ideas of Alberti and the Florentine painters. Mantegna was also an expert on ancient Roman art. His works include a series of frescoes for the palace of Duke Ludovico Gonzaga in Mantua. One scene, reproduced on this page, shows the duke—with his wife, children, and a dwarf who lived with them—holding court in an open arcade. The picture shows an outstanding use of perspective and includes many details of classical architecture.

Sandro Botticelli, one of the greatest Florentine masters, departed from the earlier Florentine style. He became the leading interpreter of *Neoplatonism* among Florentine painters. Neoplatonism was a complicated religious theory that combined ancient mythology, Greek philosophy, and Christianity to explain God, beauty, and truth. See **Neoplatonism**.

Botticelli's *Birth of Venus,* below, is based on a Greek myth. The myth tells how Venus, the goddess of beauty and love, was born in the sea and was blown to shore on a shell by the winds. The style and perspective of the picture do not follow the sculptural style developed through Masaccio. In his attempt to express spiritual qualities, Botticelli returned to an almost medieval style.



Uffizi Gallery, Florence, Italy

*Birth of Venus* by Sandro Botticelli
About 1478. Egg tempera on canvas. 1.72 by 2.72 m.

The National Gallery, London

Detail of *The Battle of San Romano* by Paolo Uccello
About 1456-1460. Tempera on wood. 1.83 m high.

Venus' body curves in such a way that she seems much like a paper doll floating in the air. The design of the picture is more flat and decorative than most Italian art after the early 1400's.

Paolo Uccello was another painter who departed from Florentine tradition. He painted *The Battle of San Romano* to show a victory by Florence over the nearby city of Siena. The battle took place in 1432, but Paolo painted the picture during the 1450's, when Florence was enjoying a period of peace. Paolo's patrons seemed to prefer art that was easygoing and not too serious. Thus, Paolo's picture, which is reproduced above, expresses no heroic feeling or illusion of realistic space. The horses look like stuffed toys and the soldiers are dressed more for parading than for fighting. The foreground seems like a setting for a play, and the background looks like a hanging painted cloth.

**Leonardo da Vinci** was probably the greatest artist of the 1400's. His *Madonna of the Rocks* (page 59) shows his mastery. The angel on the right in the picture ranks among the finest examples of classical figure painting. Before the picture yellowed with age, it showed the darkest shadows of the rocks and folds of the Madonna's robe in deep, rich colours.

### The Renaissance in Flanders

Northern European artists, like the Italians, began painting with a new emphasis on realism during the 1400's. The first great achievements in realistic painting in northern Europe appeared in the works of artists of Flanders. Most of the Flanders region lies in what are now Belgium and France.

**The Flemish style.** Flemish and Italian artists had a common interest in realism. But there were many stylistic differences between the works of the two groups of painters. The major difference resulted from the painting media used. The Italians were masters of fresco, and the Flemish excelled in oil painting. With oil, Flemish artists could create their subject matter through accumulations of realistic details. Their pictures are filled with precise representations of such things as fine textiles and delicate jewels. The fresco technique of the Italians was not as well suited to reproducing such exact details.

Unlike painters in Italy, Flemish painters had few classical Roman monuments to copy. Thus, the architectural details in Flemish painting follow the Gothic style popular among northern European artists. The Flemish figures are also less sculptural than figures in Italian painting.

Jan van Eyck's painting *The Arnolfini Wedding* (page 58) shows the Flemish mastery of detail. It is also a good example of the Flemish practice of including highly symbolic objects in realistic works. The painting is a kind of pictorial marriage certificate. The man and woman are taking their marriage vows, but no priest is present. Instead, the couple is being married by Jesus Christ. The single burning candle in the chandelier represents Jesus' mystical presence in the picture. The dog and slippers stand for everlasting faithfulness of husband and wife.

*The Descent from the Cross* by Rogier van der Weyden (page 58) also shows Flemish attention to detail. But Van der Weyden's picture is less realistic than Van Eyck's. His figures seem to have a slightly floating quality that give them a more spiritual appearance than Van Eyck's solid-looking people. Van der Weyden was also more interested in abstract design. For example, he skil-

*The Descent from the Cross*
by Rogier van der Weyden
About 1435. Oil on wood
2.2 by 2.62 m.

The Prado, Madrid

fully contrasted the parallel curves of Christ's body and the fainting Virgin Mary with the vertical forms of the other figures.

**Pieter Bruegel the Elder** was a great Flemish master of the 1500's whose works show new trends in painting. His *Return of the Hunters* (page 29) gives an aerial view of a Flemish village in winter. The painting is unusual for its time because its subject is neither religious nor based on a classical story. Instead, it portrays life in a typical northern European community of the artist's day. Bruegel's pictures encouraged later Flemish and Dutch artists to become interested in portraying the customs and manners of their own countries.

### The later Renaissance

By the early 1500's, Rome had replaced Florence as the chief centre of Italian painting. The popes lived in Rome, and they spent great sums on art to make Rome the most glorious city of the Christian world. In addition, two of the greatest artists in history—Raphael and Michelangelo—worked there. The style of painting that centred in Rome during the early 1500's is called *High Renaissance.* It combined elements of many earlier styles, including graceful figures, classical Roman realism, and linear perspective. The works of Raphael and Michelangelo best show the High Renaissance style of painting.

**Raphael** painted balanced, harmonious designs that express a calm, noble way of life. This style appealed to Italians of the early 1500's. During this period, the Roman Catholic Church was sure of its supreme position in Europe, and leading Italians were convinced that

The National Gallery, London

*The Arnolfini Wedding* by Jan van Eyck
1434. Oil on wood. 82 by 60 cm.

Uffizi Gallery, Florence, Italy

*Madonna of the Goldfinch* by Raphael
1506. Oil on wood. 107 by 77 cm.

The Louvre, Paris

*Madonna of the Rocks* by Leonardo da Vinci
About 1485. Oil on canvas. 1.99 by 1.22 m.

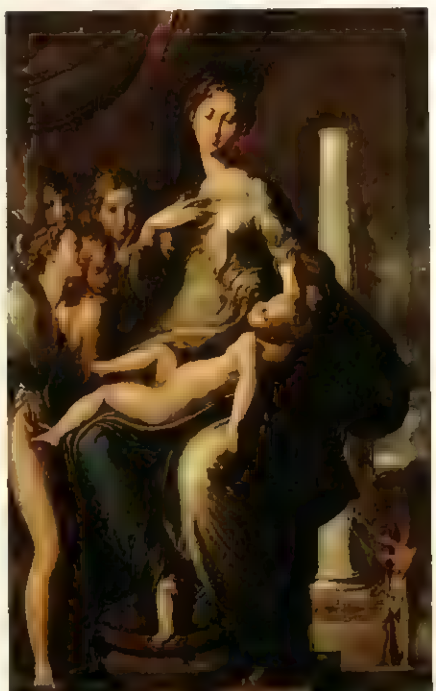
the great classical Roman civilization had been reborn and was flourishing in Italy.

Raphael was strongly influenced by Leonardo da Vinci's style of arranging figures to form a pyramid. He used this compositional form often in a series of paintings of the *Madonna* (the Virgin Mary). In the *Madonna of the Goldfinch,* which is reproduced on this page, the Madonna's body is in the centre. The two infants—Jesus and John the Baptist—are carefully placed on either side. The heads of the three figures form a triangle. The trees in the background are evenly divided between the two sides of the picture. The Madonna is as graceful as a goddess. Her manner suggests the Renaissance ideal that a good woman should be faithful, humble, and pure.

**Michelangelo** moved to Rome in the early 1500's to work for Pope Julius II. The artist worked as a sculptor until the pope ordered him to decorate the ceiling of the Siştine Chapel in the Vatican.

*The Creation of Adam* (page 60) is one fresco from the chapel ceiling. It shows God moving on a cloud among many angels. He extends a finger toward Adam, the first human being. Adam raises his arm to receive the spark of life. Michelangelo's human figures are more sculptural and solid-looking than Raphael's. Raphael's figures seem happier and more graceful, but not so heroic and powerful as Michelangelo's.

The calm and harmony of the High Renaissance did not last beyond the early 1500's. In the 1520's, the Roman Catholic Church first felt the disturbances of the Pro-



Uffizi Gallery, Florence, Italy

*Madonna of the Long Neck* by Parmigianino
1535. Oil on wood. 2.16 by 1.32 m.

Sistine Chapel, The Vatican, Rome

*The Creation of Adam* by Michelangelo
1511. Fresco. Figures larger than life size.

testant Reformation. During this time, the pope employed Michelangelo to paint *The Last Judgment*, a fresco on a wall of the Sistine Chapel. In this work, Michelangelo continued to create heroic figures. However, he no longer painted figures that reflected the ideal classical world of the High Renaissance. Instead, the figures in the work seem to be frustrated and driven by emotion. They were examples of a new style in painting called *mannerism.*

**Mannerism** flourished in Europe from about 1520 to about 1600. The movement was especially strong in central Italy. The works of mannerist artists show the influence of the beautiful figure forms of Raphael and the heroic style of Michelangelo. However, the mannerists stressed exaggerated poses and distortion of figures in their pictures.

The *Madonna of the Long Neck* (page 59) by Parmigianino is a good example of a mannerist painting. The Madonna has a long stalklike neck, long thin hands, and a look of over-refined elegance. Compare her with Raphael's Madonna. The Raphael figure sits solidly on a rock with the two children standing quietly beside her. Parmigianino's Madonna is supposed to be seated, but her stretched form makes it difficult to tell whether or not she is. The long and rather unnatural body of the bald-headed Christ child seems to be slipping off her lap.

**Venetian painting.** Venice ranked second only to Rome as a centre of Italian art during the 1500's. Venice was a commercial city that handled much of the trade between Europe and the East. Venetian painters showed the influence of Eastern art in their fascination with colour. Their works also show a trend away from interest in the hard outline and sculptural and heroic figures found in the paintings of Florence and Rome. Venetian painters tried to please and relax the viewers rather than inspire them to noble deeds.

The Venetian painters became masters of oil painting. The texture of the paint itself interested some Venetian artists more than the subject matter. These painters brushed on their paint in thick strokes. Their emphasis on paint texture is called *painterly.*

Giorgione was one of the earliest Venetian masters.

The Louvre, Paris

*Concert Champêtre* by Giorgione
About 1510. Oil on canvas. 1.1 by 1.38 m.

Isabella Stewart Gardner Museum, Boston, Massachusetts, U.S.A.

*The Rape of Europa* by Titian
1562. Oil on canvas. 1.78 by 2.05 m.

Santo Tomé, Toledo, Spain

*The Burial of Count Orgaz* by El Greco
1586. Oil on canvas. 4.88 by 3.61 m.

His *Concert Champêtre* (Holiday in the Country), shown on page 60, is a painting of a poetic dream. It invites the viewer to an imaginary world where he can relax in the presence of beautiful women and lovely music. Giorgione made the outlines of his figures very soft. Edges of the figures and objects blend into shadows. The artist obviously was more concerned with brushing in colours than with drawing sharp borders.

Titian went much further than Giorgione in the use of oil paint to make bold brushstrokes. In *The Rape of Europa* (page 60), Titian brushed on rich red and blue colours to create a powerful emotional impact. The colours swirl together, some in thick gobs and some in thin washes. The colour of one object seems to blend into the colour of another. The artist seems almost to have painted the entire picture in sweeping brushstrokes.

Tintoretto was a student of Titian. He painted with great speed and, like Titian, often brushed on his colours with bold, loose strokes (see the painting in the **Moses** article). One critic even accused him of painting with a broom. Tintoretto became a master at showing figures in vigorous action. He bent many of his figures unnaturally in the way of the mannerists to achieve this effect. Tintoretto's picture of Moses, and his picture of Saint Mark on page 34 of this article, are full of action.

**El Greco** of Spain was one of the greatest artists of the late Renaissance. *The Burial of Count Orgaz* on this page is an example of his work. The picture combines the exaggerated figure style of mannerism, the colour and brushstrokes of the Venetians, and the flat style of Byzantine painting. The result is a picture filled with spiritual intensity. El Greco's art marks the highest point of mannerism. It also introduced a new style in Europe, the *baroque*.

## *The 1600's and 1700's*

Two important developments that took place in Europe during the 1500's and 1600's greatly influenced the history of art. One was the Counter Reformation, the Roman Catholic Church's response to the Protestant Reformation. The other was the rise of nationalism in many European countries. These developments helped bring about a major painting style—baroque. Baroque and a related style, *rococo,* dominated European painting during the 1600's and 1700's.

**The beginning of baroque.** The Reformation forced the Roman Catholic Church to organize against Protestantism. Church officials wanted to use art in order to spread Catholic ideas and teachings. The church told artists that they should create religious paintings that would be realistic and easy to understand and—most importantly—would inspire religious emotional reactions in viewers. These qualities formed the basis of the baroque painting style.

The baroque style began in Rome in about 1600 and quickly spread to other places where the church had power. Baroque art also came to have great influence in many Protestant nations. The people in these countries had developed strong nationalistic feelings. That is, they had become very patriotic and conscious of their national heritages. Their rulers wanted to build empires and increase their own authority. Many rulers encouraged artists to use the baroque qualities of clarity, emotionalism, and realism to increase the people's nationalistic feelings.

**Annibale Carracci and Michelangelo Caravaggio** of Italy were the most important early baroque painters. They differed in the way they treated their subject matter, and their methods became major styles within the baroque movement.

Carracci's approach to baroque art appears in his painting *Hercules at the Crossroads,* shown below. This work, completed in about 1597, shows the mythical Greek hero Hercules deciding whether to follow the easy path of pleasure and sin or the difficult path of noble deeds. Carracci chose this subject because it allowed him to paint an *allegory,* a moral lesson in the form of a story. Carracci was telling his viewers that they, like Hercules, could acquire fame and fortune if they chose hard work and virtue rather than life's easy pleasures.

Carracci abandoned the exaggerated, rather flat figures of mannerist art and returned to the solid, three-dimensional forms of Michelangelo and Raphael. He made Hercules look like a classical Roman hero. Many artists became followers of Carracci because they believed he made the traditional classical style seem real and meaningful again.

Caravaggio also made his figures seem real. But his figures look like ordinary poor people of his time. Caravaggio's *The Supper at Emmaus,* shown next to the Carracci painting, is based on a Bible story. After Jesus was crucified, He miraculously appeared to two of His followers and dined with them in a village called Emmaus. Caravaggio portrayed the event as if it took place in a run-down Italian country inn. Jesus' two friends are shown as common Italian labourers. A typical Italian innkeeper stands next to Jesus in the work, even though no innkeeper appears in the Bible story. Light streaming down from the upper left dramatically centres the viewer's attention on Jesus.

Caravaggio's art appealed to many foreign painters living in Rome. His realism stimulated these painters to portray ordinary people and places.

**Other baroque masters.** Peter Paul Rubens of Flanders was one of the greatest of the painters who adopted the baroque style. He skilfully combined Caravaggio's simple realism and Carracci's realistic classical style. Rubens was also influenced by the brilliant colours of such painters as Titian and by the Venetian technique of painting in thick oils.

The *Elevation of the Cross* (page 63) shows Rubens' baroque style. This painting is a highly emotional religious scene. Several half-naked bodies strain to lift Jesus onto the cross as spectators look on in sorrow and fear. Rubens intensified the feeling of action and struggle by drawing his composition in diagonal lines. He further heightened the picture's emotional appeal by painting the highlights in thick masses of pigment and the dark colours in semitransparent brownish glazes. The paint-

Museo e Gallerie Nazionali di Capodimonte, Naples, Italy

*Hercules at the Crossroads* by Annibale Carracci
About 1597. Oil on canvas. 1.68 by 2.38 m.

The National Gallery, London

*The Supper at Emmaus* by Michelangelo Caravaggio
About 1598. Oil on canvas. 1.39 by 1.95 m.

Cathedral of Notre Dame, Antwerp, Belgium

*Elevation of the Cross* by Peter Paul Rubens
1611. Oil on wood. 4.62 m high.

The Louvre, Paris

*Portrait of Charles I Hunting* by Anton Van Dyck
About 1635. Oil on canvas. 2.72 by 2.12 m.

The Prado, Madrid

*The Maids of Honour* by Diego Velázquez
1656. Oil on canvas. 3.18 by 2.76 m.


Frans Halsmuseum, Haarlem, the Netherlands

*Banquet of Officers of the Civic Guard of Saint George at Haarlem, 1616* by Frans Hals
1616. Oil on canvas. 1.75 by 3.24 m.

ing shows Rubens' remarkable ability in drawing the human body.

Rubens operated a large studio and employed many assistants, of whom Anton Van Dyck was the most famous. Van Dyck gained his greatest fame as a portrait painter. He became a painter at the court of King Charles I of England in 1632. Van Dyck's *Portrait of Charles I Hunting* (page 63) is called a *state portrait* because it shows a ruler in an aristocratic pose. Such portraits were intended to display the virtues and dignity of the ruler. This type of elegant portrait became popular during the 1600's.

Diego Velázquez, who painted at the Spanish court in the mid-1600's, was another master of baroque. He became a good friend of Rubens in 1628, and Rubens introduced him to the rich, colourful style of the Venetian artists. Velázquez was primarily a portrait painter. His pictures were intended as state portraits, but they show less elegant haughtiness than Van Dyck's portrait of Charles I. Velázquez' portraits seem more like personal pictures from a family album than paintings advertising the grandeur and power of Spain.

Velázquez' *The Maids of Honour* (page 63) shows the young Spanish princess Margarita surrounded by her maids and friends. Velázquez himself stands in the left background, holding a brush and looking toward the viewer. A mirror at the back of the room reflects the smiling faces of King Philip IV and Queen Mariana.

**Dutch painting.** By the late 1600's, the Netherlands had become one of the world's major commercial and colonial powers. As the country gained wealth, the Dutch people became interested in luxury goods, including works of art.

The Netherlands was a Protestant nation. The Dutch did not appreciate religious subjects as much as the people of Catholic countries did. Many of the Dutch were middle-class people who could afford to buy works of art. They were not interested in the classical Roman tradition in art that was popular among the aristocratic classes of other countries.

The Dutch liked almost any subject that reminded them of their own comfortable middle-class lives. Dutch painters developed a distinct style during the baroque period. Many Dutch artists specialized in painting specific subjects, such as domestic scenes or tavern scenes. Painting that deals with such ordinary, everyday subjects is called *genre* painting.

Jan Vermeer probably ranks as the greatest Dutch genre painter of the 1600's. Vermeer and other Dutch genre artists painted small pictures, most of which had smooth, glazed surfaces. Vermeer, a master of painting interior scenes, usually portrayed women working at quiet household tasks. His art is particularly noted for its treatment of sunlight as it floods into a room or falls on objects. An example is *Young Woman with a Water Jug* (page 65).

Still-life paintings of common, everyday subjects became popular in the Netherlands. *Still Life* by Willem Claesz Heda (page 65) shows the remarkable realism that is a feature of much Dutch painting of that time. Heda's painting shows the remains of a meal. This picture includes strong painterly touches. It illustrates Heda's interest in showing the way light glitters on glass and metal.

Frans Hals, another Dutch artist, developed a painting style close to that of Rubens. Hals's finest works are por-

The Metropolitan Museum of Art, New York City,
Gift of Henry G. Marquand, 1889

*Young Woman with a Water Jug* by Jan Vermeer
About 1660. Oil on canvas. 46 by 41 cm.

Museum Boymans-van Beuningen, Rotterdam, the Netherlands

*Still Life* by Willem Claesz Heda
1634. Oil on wood. 43 by 57 cm.

Staatliche Kunstsammlungen, Kassel, Germany

*Jacob Blessing the Sons of Joseph* by Rembrandt
1656. Oil on canvas. 1.76 by 2.11 m.

traits. They are brilliant, cheerful, and refreshing—like the artist's own personality. With a few quick brushstrokes, Hals could give the impression of great detail and capture a feeling of warmth.

Hals did several large group paintings, including *Banquet of Officers of the Civic Guard of Saint George, 1616* (page 64). Hals painted the officers as if they were seated at a festive dinner party. He made the scene look casual, but he carefully organized the composition of the painting. He balanced the picture by making the diagonal lines of the men's sashes and the diagonals of the curtains and banners run in opposite directions.

Rembrandt van Rijn became the greatest master of Dutch painting. He liked to paint religious subjects, even though he followed no particular religious faith. Rembrandt was most interested in the human side of characters in the Bible. He showed the deep human emotions involved in Bible stories.

Rembrandt's *Jacob Blessing the Sons of Joseph* (page 65) shows the aged and dying Jacob blessing his young grandsons. The old man reaches for the heads of the two little boys. Joseph, the proud father, sits on the bed, and the loving mother stands nearby. Rembrandt handled the scene with great tenderness. The picture shows his special skill in portraying old men.

**Nicolas Poussin** was a lonely, quiet Frenchman who painted in Rome during the mid-1600's. He loved the art and literature of ancient Rome. Poussin tried to portray classical and Biblical history so vividly that the stories of ancient times would live again.

Poussin painted landscapes. But like nearly all landscape artists before the 1800's, he made his scenes serve only as a background for historical subjects. His *Saint John on Patmos,* reproduced below, portrays the apostle John seated among the ruins of a classical temple. This painting shows that Christianity has triumphed over pagan religion. However, Poussin wanted the heroes of the Bible to look like the gods and heroes of classical times. So he made the saint look like a pagan Greek philosopher.

Poussin's style differs sharply from most painting of the baroque period. Poussin did not use the swirling, thick colours popular with most baroque painters. Instead, he painted solid, three-dimensional objects. For example, the cylindrical pieces of columns and square-cut stonework scattered around the saint, and even the trees and clouds, seem hard and solid. Poussin also gave his paintings a calm, well-ordered quality, avoiding the emotionalism of baroque art.

**Rococo** was a painting style that developed out of baroque toward the end of the 1600's. Rococo painting reached its greatest popularity in France from about 1720 to 1780.

Rococo artists gave their paintings the decorative

*Saint John on Patmos* by Nicolas Poussin
About 1650. Oil on canvas. 1.02 by 1.36 m.

The Art Institute of Chicago, A. A. Munger Collection

quality of baroque. But they painted most of their pictures on a smaller scale than did the baroque painters. Much baroque painting was energetic and heroic. Rococo painting communicated a sense of relaxation. It also was light-hearted and had none of the seriousness found in the paintings of Poussin and his followers. Rococo artists dealt with poetic and playful themes. These painters filled their works with flowing curves and bright, shimmering surfaces.

Antoine Watteau's *The Embarkation for Cythera,* shown below, illustrates the rococo style. This picture portrays a group of French aristocrats preparing to leave the mist-covered island of Cythera. According to Greek mythology, the island was the first home of Aphrodite, the goddess of love. Such light-hearted, poetic, and imaginary scenes reflected the taste of many French aristocrats of the time.

The rococo painter who best portrayed the tastes of the French aristocracy was Jean Honoré Fragonard. His *The Swing,* right, has the same Rubens-like painterly quality as Watteau's work. But the subject is even less serious than Watteau's. The painting shows a pretty young girl being pushed on a swing by her elderly husband. As she swings upward, she sees her handsome young lover on the other side of the hedge and flips him her shoe. The picture is typically rococo in its playful subject matter and make-believe setting.

The Wallace Collection, London

*The Swing* by Jean Honoré Fragonard
About 1768. Oil on canvas. 83 by 66 cm.

*The Embarkation for Cythera* by Antoine Watteau
1717. Oil on canvas. 1.28 by 1.93 m.

The Louvre, Paris

# *The 1800's*

The 1800's was a time of revolution in the arts. Through a series of major movements, painters repeatedly reinterpreted the purpose of painting and how they should portray their subject matter. The movements included neoclassicism, romanticism, realism, impressionism, and postimpressionism. During the 1800's, France became the centre of painting.

**Neoclassicism** was a major movement in painting during the late 1700's and early 1800's. It became especially important in France. Neoclassicism largely replaced rococo painting, which had reflected the tastes of the French aristocracy. The French Revolution, which began in 1789, ended the rule of the aristocracy and established a democratic form of government in France. The leaders of the new government tried to model France on classical Rome. They stressed the virtues they saw in Roman civilization. These virtues included discipline and high moral principles. Neoclassical artists helped educate the French people in the goals of the new government. They painted inspirational scenes from Roman history to create a feeling of patriotism.

Jacques Louis David of France became the leading neoclassical painter. He painted *The Oath of the Horatii* (page 69) five years before the French Revolution began. Even so, the picture illustrates the artistic ideals of neoclassicism. It shows three brothers swearing that they will fight for the Roman Republic, even though their decision brings sorrow to their families. The picture expresses the principle that public duty, self-sacrifice, and patriotism are greater values than personal safety.

David's neoclassicism involved style as well as subject matter. To emphasize the message in his pictures, David omitted distracting details and painterly effects. He painted simple, solidly modelled forms in bright, strong colours. The result was balanced and clear.

Napoleon I rose to power in France in the late 1790's. Some neoclassicists saw a relationship between his reign and the great age of ancient Rome that began with the reign of the Emperor Augustus. Napoleon's influence on French artists helped shift the emphasis in neoclassical subject matter from ancient to modern history. Some painters portrayed Napoleon as a modern hero.

Many neoclassical artists who painted scenes of their own time abandoned the simplicity that characterized David's work. They included more figures and details in their works and made the action more complicated. But they continued to use bright, clear colours and to paint firmly modelled forms.

About 1820, Jean Auguste Dominique Ingres of France developed a new approach to neoclassical painting. Ingres abandoned the earlier neoclassical emphasis on firm figures; bright, strong colours; and patriotic messages. To Ingres, line was the major element in painting. He painted many uncluttered, graceful portraits that show his emphasis on line. His portrait *Comtesse d'Haussonville* (page 70) is a clear, perfectly balanced work that expresses no message or heroic ideal.

**Romanticism** was a reaction against the neoclassical emphasis on balanced, orderly pictures. Romantic paintings expressed the imagination and emotions of the artists. The painters replaced the clean, bright colours and harmonious compositions of neoclassicism with scenes of violent activity dramatized by vigorous brushstrokes, rich colours, and deep shadows.

Romanticism, like neoclassicism, was most important in France. By 1830, it had largely replaced neoclassicism as the major French painting style. But many European artists of the earlier 1800's helped shape the romantic style. Théodore Géricault of France used subject matter to arouse the emotional interest of the viewer. For example, *The Raft of the Medusa* (page 69) vividly shows the sufferings of the survivors of an actual shipwreck of the early 1800's. The artist presented a far greater range of emotions than ever appeared in a neoclassical painting. Géricault's painting technique also broke with neoclassical tradition. He used brushstrokes and colour to add to the intense feeling produced by his subject. Instead of painting space and outlines clearly, he used swirling shadows and gleaming highlights.

Francisco Goya of Spain became a forerunner of both romanticism and realism. He completely rejected neoclassical restrictions on subject matter. Goya painted kings, commoners, insane people, and soldiers. He never glorified his subjects. Instead, he portrayed them as he saw them—combining realistic details with his own interpretation of their character. Goya's *Majas on a Balcony* (page 70) shows his ability to add a romantic touch to ordinary scenes. The *majas* (women) look real, yet mysterious. It is impossible to tell what they are doing or thinking.

Two English painters—John Constable and Joseph M. W. Turner—made important contributions to romanticism. Constable believed that artists should get their subject matter through direct observation of nature. He also believed that painters should express their emotions in their work. Constable became a master of landscape painting. He developed a style of rough brushstrokes and broken colour to catch the effects of light in the air, trees bent in the wind, and pond surfaces moved by a breeze. In *Stoke-by-Nayland* (page 71) and other works, he tried to capture in oil paintings the fresh quality of watercolour sketches.

Turner became increasingly concerned with the effects of colour. In his late works, colour became one dazzling swirl of paint on the canvas. In *Burning of the Houses of Parliament* (page 71), form seems to dissolve into the surface of the picture. The Parliament buildings are hidden in a burst of orange, yellow, brown, and grey smoke. The sky is full of colour, and the entire scene is reflected in the violently vibrating waters below.

The French romantics admired the paintings of Constable and Turner. They used the English paintings as models in departing from the carefully composed neoclassical works. The influence of Constable and Turner also appeared during the late 1800's in the works of the French impressionists.

Eugène Delacroix became the most famous of the many French romantic painters. Like other romantics, Delacroix found excitement in unusual events and faraway places. His painting *Jewish Wedding in Morocco* (page 70) shows this feature of his work. It also illustrates his fascination with the effects created by the interaction of strange heavy jewellery, swirling garments, and ornaments. In addition, the painting is a good exam-

The Louvre, Paris

*The Oath of the Horatii* by Jacques Louis David
1784. Oil on canvas. 3.30 by 4.25 m.

The Louvre, Paris

*The Raft of the Medusa* by Théodore Géricault
1819. Oil on canvas. 4.91 by 7.16 m.

The Metropolitan Museum of Art, New York City, the H. O. Havemeyer Collection, 1929

*Majas on a Balcony* by Francisco Goya
About 1810. Oil on canvas. 1.95 by 1.26 m.

© The Frick Collection, New York City

*Comtesse d'Haussonville* by Jean Auguste Dominique Ingres
1845. Oil on canvas. 1.32 by 0.92 m.

The Louvre, Paris

*Jewish Wedding in Morocco* by Eugène Delacroix
1839. Oil on canvas. 1.05 by 1.4 m.

The Art Institute of Chicago, Mr and Mrs. W. W. Kimball Collection

*Stoke-by-Nayland*
by John Constable
1836. Oil on canvas.
1.26 by 1.69 m.

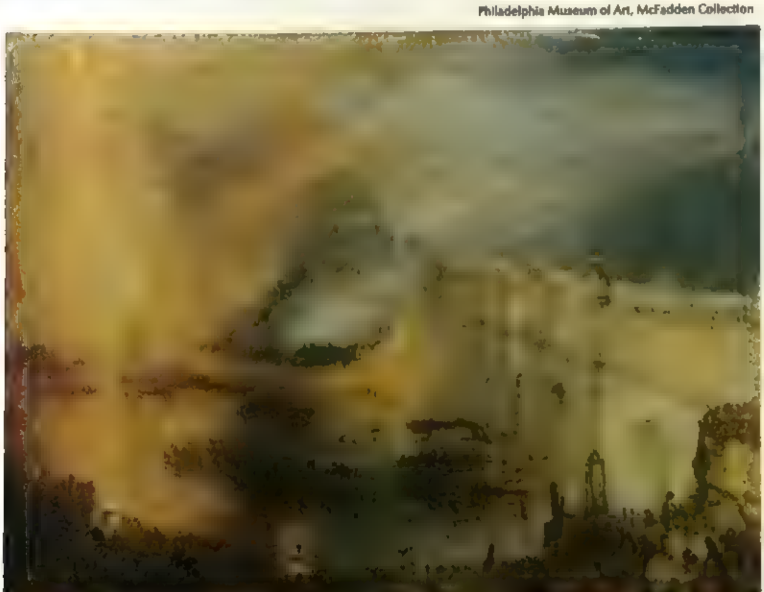
ple of the romantic artist's disregard for realistic space. The foreground and background merge into shadows.

**Realism.** By the mid-1800's, neoclassical and romantic painting had become, to a great extent, stale and artificial. The works of Thomas Couture, a follower of Ingres, illustrate this decline. In *Romans of the Decadence* (page 72), Couture tried to show how the Romans lost their greatness through wild living. But in spite of the subject matter, the work seems lifeless. It is an example of how many talented artists had reached an artistic dead end by continuing to paint in exhausted traditions.

As neoclassicism and romanticism declined, a new movement—realism—developed in France. Early signs of realism appeared in French paintings that show the gentle qualities of nature. *A View near Volterra* (page 72), painted by Camille Corot in 1838, is an example of this early realism. A similar delight in nature appears in the work of a group of French artists who settled in the village of Barbizon in the 1830's and 1840's. Known as the Barbizon School, this group included Charles Daubigny, Jules Dupré, Jean François Millet, and Théodore Rousseau. Their simple paintings of pastures, forests, and rural cottages contrast sharply with the artificial neoclassical and romantic art of the day.

In the mid-1800's, Gustave Courbet became the first great master of realistic painting. Courbet painted

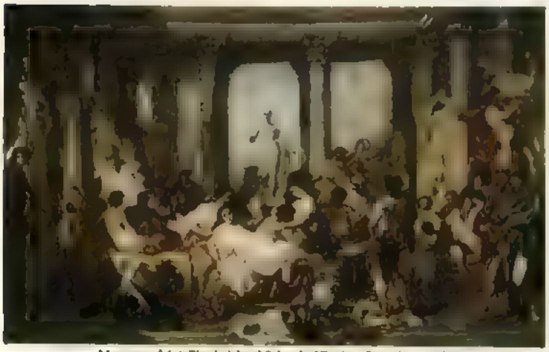
Philadelphia Museum of Art, McFadden Collection



*Burning of the Houses of Parliament*
by Joseph M. W. Turner
About 1835. Oil on canvas.
0.92 by 1.23 m.

The Louvre, Paris

*The Artist's Studio* by Gustave Courbet
1855. Oil on canvas. 3.59 by 5.98 m.



Museum of Art, Rhode Island School of Design, Providence, Rhode Island, U.S.A.

Study for *Romans of the Decadence* by Thomas Couture
About 1846. Oil on canvas. 43 by 67 cm.

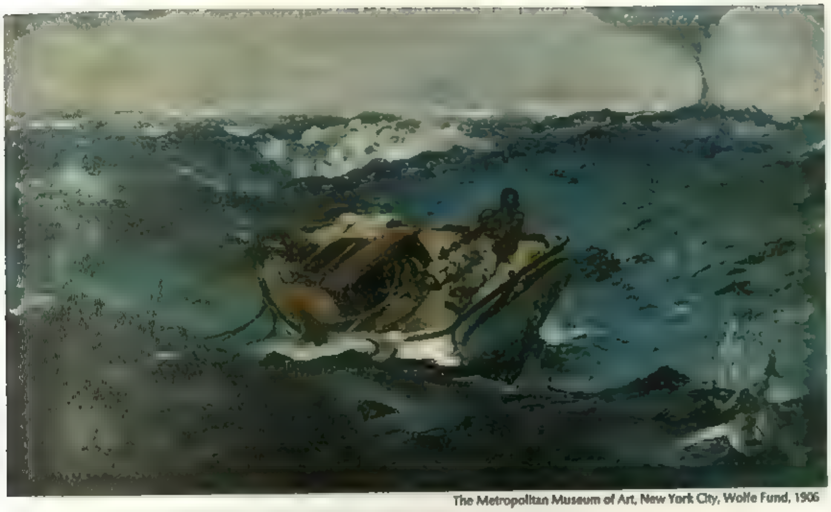
landscapes, but his vision of nature was not so idealized as that of the Barbizon painters. Courbet recorded the world around him so sharply that many of his works were considered social protests. In one painting, for example, he portrayed an old man and a youth in the agonizing work of breaking rocks with hammers. The artist implied that something is wrong with a society that allows people to spend their lives at such labour.

*The Artist's Studio,* on this page, is one of Courbet's masterpieces. It shows people from real life. Courbet himself sits at an easel while a nude model looks over his shoulder. A group of beggars and townspeople is on the left. On the right are some of the artist's friends, including the poet Charles Baudelaire on the far right.

The neoclassicists called Courbet's paintings low and vulgar. But Courbet's works helped change the course

National Gallery of Art, Washington, D.C., Chester Dale Collection

*A View near Volterra*
by Camille Corot
1838. Oil on canvas.
70 by 95 cm.



*The Gulf Stream*
by Winslow Homer
1899. Oil on canvas.
72 by 125 cm.

The Metropolitan Museum of Art, New York City, Wolfe Fund, 1906

of art. The paintings were based on the artist's honest, unsentimental observations of life around him. From Courbet's time to the present day, many painters have adopted his approach.

**The Pre-Raphaelite Brotherhood** was an English art and literary movement founded in 1848. The leading painters in the movement were William Holman Hunt, Sir John Everett Millais, and Dante Gabriel Rossetti. The Pre-Raphaelite painters stood apart from the major art movements of their century. They wanted to return to what they believed was the purity and innocence of painting before Raphael. Most Pre-Raphaelite art has a strong moral message. The artists often expressed their message through religious paintings.

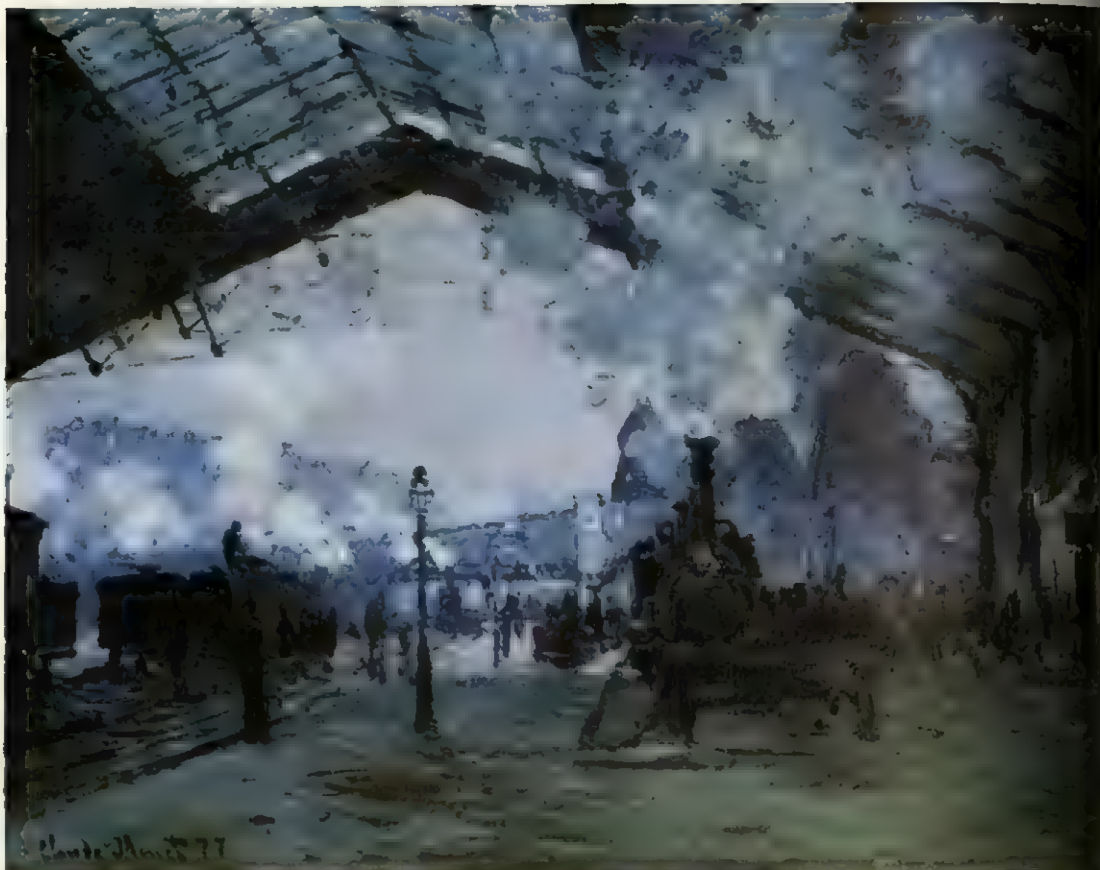
**United States painting.** Painting had an unimportant role in early American society. The pioneers were too busy taming the wilderness and building a nation to pay much attention to the arts. But by the early 1800's, many Americans had gained enough wealth and leisure time to begin to enjoy and support painting.

Until the mid-1800's, American painting was closely tied to European art. Most important American painters studied in Europe. Benjamin West, for example, left the United States and settled in England, where he taught many of the first important American painters. They included John Singleton Copley, Ralph Earl, Samuel F. B. Morse, Charles Willson Peale, Rembrandt Peale, Gilbert Stuart, and John Trumbull. Most of their paintings were portraits or pictures of historical events.

By the mid-1800's, some American painters had begun to believe that American art should differ from European art. Many artists felt that the landscape of the

The Metropolitan Museum of Art, New York City, Alfred N. Punnett Fund and Gift of George D. Pratt, 1934

*Max Schmitt in a Single Scull*
by Thomas Eakins
1871. Oil on canvas.
82 by 117 cm.



The Art Institute of Chicago, Mr and Mrs. Martin A. Ryerson Collection

*Old St. Lazare Station, Paris* by Claude Monet
1877. Oil on canvas. 60 by 80 cm.

New World could provide the source for a truly American style. They painted scenes from nature in a romantic way. These scenes reflected their patriotic pride in the magnificence of the land.

Several American painters were attracted by the spectacular scenery along the Hudson River in New York's Catskill Mountains. These painters—called the Hudson River School—included Thomas Cole, Thomas Doughty, and Asher B. Durand. Other artists painted in the West. Albert Bierstadt painted huge pictures that show the splendour of the Rocky Mountains. George Caleb Bingham painted landscapes and scenes of pioneer life along the American frontier. George Catlin painted scenes of Indian life.

The idealism of romantic American landscape painting ended during the American Civil War (1861-1865). American artists once again became influenced by European painting. A few American artists, including Mary Cassatt, painted in the impressionist style that developed in France during the late 1800's. But most American artists followed more traditional European styles, including neoclassicism, romanticism, and realism.

Thomas Eakins of Philadelphia learned painting techniques in the Paris studio of a conservative neoclassical painter named Jean Léon Gérôme. However, Eakins developed a style more related to the French realists. His picture *Max Schmitt in a Single Scull* (page 73) is both a landscape and a portrait. Everything in the painting is carefully placed. Eakins portrayed perspective carefully, and the scene appears complete and uncluttered. The serious and thoughtful quality in Eakins' work had an important influence on later American painting.

Winslow Homer was an American artist whose paintings of the sea have a strong romantic quality. During the late 1800's, Homer became fascinated by what he believed was a particularly American struggle between human beings and the forces of nature. The sea, with its possibilities for change and violence, attracted Homer. He settled on the coast of Maine, where he captured in many of his paintings the shifting moods of the Atlantic Ocean. Homer's feeling for the drama of humanity against the sea appears in his famous painting *The Gulf Stream* (page 73).

**Edouard Manet** was a French artist who revolutionized painting in the mid-1800's. Manet studied under the neoclassicist painter Thomas Couture, who taught him the traditional painting methods. But Manet developed a new approach to art. He believed that paintings do

The Louvre, Paris

*Luncheon on the Grass*
by Edouard Manet
1863. Oil on canvas.
2.08 by 2.65 m.

National Gallery of Art, Washington, D.C., Gift of Sam A. Lewisohn

*Oarsmen at Chatou* by Pierre Auguste Renoir
1879. Oil on canvas. 81 by 100 cm.

Yale University Art Gallery, New Haven, Connecticut, U.S.A. Bequest of Stephen C. Clark

*The Night Café* by Vincent van Gogh
1888. Oil on canvas. 72 by 92 cm.

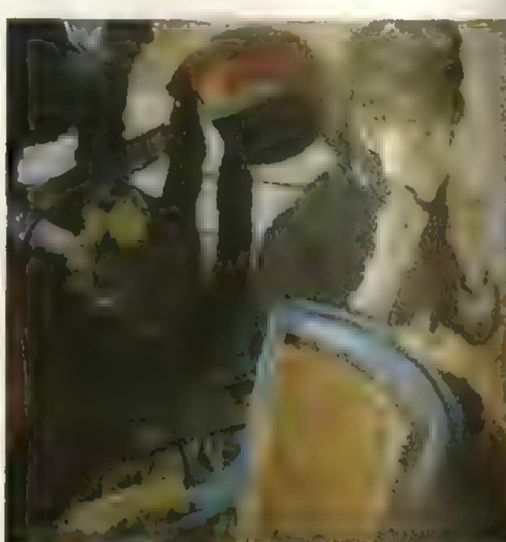
not have to express messages or portray emotions. Manet was chiefly interested in painting beautiful pictures. To him, beauty resulted from a combination of brushstrokes, colours, patterns, and tones.

Viewers could find no meaning in Manet's works, and so they considered him either a fraud or a poor painter. But since Manet's time, most painters have emphasized the picture itself, rather than its storytelling function.

Manet exhibited his first painting in the late 1850's. In 1863, his *Luncheon on the Grass* (page 75) appeared. This work illustrates Manet's lack of concern for story. It shows two men reclining on the grass. They are dressed in city clothes, which was not the usual costume for a country outing. Two women are with them—one nude and sitting on the grass and the other bathing in a lake. The figures seem to be paying no attention to one another. People who viewed the painting could make no sense of the seemingly unrelated figures. They believed that if Manet were telling any story at all, it was indecent. Actually, Manet had borrowed the subject matter from Giorgione's *Concert Champêtre* (page 60).

**Impressionism** was developed by a group of French painters who did their major work between about 1870 and 1910. The impressionists included Claude Monet, Pierre Auguste Renoir, and Edgar Degas.

Manet, the realists, and the romanticists all influenced the impressionists. Like Manet, the impressionists rejected the idea that a painting should tell a story. Like the realists, they chose to paint scenes from everyday life, including buildings, landscapes, people, and scenes of city traffic. Most of the people in their pictures were ordinary middle-class city dwellers—like the painters themselves. The impressionists admired Delacroix and the other romanticists, not for their emotionalism, but for their use of spectacular colour.



The Museum of Modern Art, New York City. Gift of Mrs. David M. Levy

*At the Milliner's* by Edgar Degas
About 1882. Pastel on paper. 70.2 by 70.5 cm.

*Where Do We Come From? What Are We? Where Are We Going?* by Paul Gauguin
1897. Oil on burlap.
1.39 by 3.74 m.

Museum of Fine Arts, Boston, Massachusetts, USA

The Art Institute of Chicago, Helen Birch Bartlett Memorial Collection

*Sunday Afternoon on the Island of La Grande Jatte*
by Georges Seurat
1886. Oil on canvas. 2.06 by 3.06 m.

Solomon R. Guggenheim Museum Collection, New York City

*The Clockmaker* by Paul Cézanne
1900. Oil on canvas. 92 by 73 cm.

The impressionists developed a revolutionary painting style. They based it on the fact that nature changes continually. Leaves move in the wind, light transforms the appearance of objects, reflections alter colour and form. As the viewer moves, the perspective of what is seen changes. The impressionists tried to create paintings that capture ever-changing reality at a particular moment—much as a camera does. Monet's *Old St. Lazare Station, Paris* (page 74) captures the rising smoke of steam engines, the dampness caused by the steam, and the shimmering light reflecting off rails and wheels.

Renoir's *Oarsmen at Chatou* (page 75) portrays a specific moment of activity as it appears to the eye. It also illustrates another quality of much impressionistic painting—lightheartedness.

Degas was the only important impressionist who concentrated on indoor as well as outdoor scenes. Many of his paintings catch girls and women at an informal or private moment—bathing, shopping, or taking a dancing lesson. Degas' pastel *At the Milliner's* (page 76) shows how he used unusual compositional techniques. He showed the scene from an unusual angle and even cut off part of his subject matter at the edge of the picture.

**Postimpressionism,** unlike impressionism, was not a unified movement. The term was first used by critics of the 1900's. It described a group of artists who attempted in various ways to extend the visual language of painting

beyond impressionism. The most influential postimpressionists were Paul Cézanne, Paul Gauguin, and Vincent van Gogh. Other postimpressionists included Henri Rousseau, Georges Seurat, and Henri de Toulouse-Lautrec. All were French except van Gogh, who was Dutch.

Like Manet and the impressionists, Cézanne made no attempt to tell stories in his pictures. Unlike the impressionists, who emphasized light, Cézanne stressed form and mass. He said he wanted "to make of impressionism something as solid and durable as the paintings in the museums." Cézanne's search for new painting methods led him to new ways of structuring his subject matter. For example, in the portrait *The Clockmaker* (page 77), Cézanne rearranged the man's features into slightly diagonal lines and made his left forearm unnaturally long. These distortions add force to the composition and give the subject an appearance of permanence and strength. Cézanne's genius for rearranging forms influenced the cubist movement of the early 1900's.

Gauguin's pictures, unlike Cézanne's, are highly decorative. Gauguin stressed flat colour, strong patterns, unshaded shapes, and curved lines. Cézanne avoided portraying emotions in his works. But Gauguin explored his deep personal feelings through his pictures.

Gauguin constantly searched for purity and simplicity in life. His search led him to the South Seas, where he settled on the island of Tahiti. While there, he painted *Where Do We Come From? What Are We? Where Are We Going?* (page 76). In this picture, Gauguin tried to state basic questions about human existence. The figures represent the various ages through which a person passes from birth to death. Gauguin made the figures look puzzled to stress his belief that humanity never can answer the questions asked in the painting's title.

Like Gauguin, van Gogh wanted to express his innermost feelings through his art. He believed he could achieve this goal through the use of brilliant colour and violent brushstrokes. He applied his oil colours directly from the tube, without mixing them. Van Gogh's brushstrokes resemble choppy furrows of powerful colour. The result was an art of passionate intensity. *The Night Café* (page 76) is an example of the intensity of his art.

Rousseau had one of the most unique styles in the history of art. He painted dreamlike, mysterious scenes that resemble the surrealistic painting scenes of the 1920's. *The Sleeping Gypsy,* reproduced on this page, illustrates the remarkable individuality of his style. In this painting, Rousseau created a sense of haunting mystery by placing the sleeping figure and the lion in a dreamlike landscape.

Seurat created a painting style called *pointillism, divisionism,* or *neoimpressionism.* He used it in his masterpiece, *Sunday Afternoon on the Island of La Grande Jatte* (page 77). This huge painting consists of tiny dots of pure colour. The colour of each dot contrasts with the colour of the dot next to it. Seen from a distance, the colours blend in the eye of the viewer. Seurat's art reflects a style of complete contrast to the style of the impressionists. Impressionist art is natural and direct. Seurat's paintings are stiff, and his figures seem immovable.

Toulouse-Lautrec painted scenes from the night life in the cafés and music halls of Paris. His lively paintings of actresses, circus performers, dancers, and singers are brilliant examples of fine drawing and psychological insight. A detail of Toulouse-Lautrec's *Trapeze Artist at the Medrano Circus* appears on page 41.

The Museum of Modern Art, New York City, Gift of Mrs. Simon Guggenheim

*The Sleeping Gypsy* by Henri Rousseau
1897. Oil on canvas. 1.30 by 2.01 m.

Royal Museum of Fine Arts, Copenhagen, Denmark, J. Rump Collection

*Landscape at Collioure* by Henri Matisse
1905. Oil on canvas. 46 by 55 cm.

Artists of the 1900's have continued the search for new approaches to painting that characterized the work of the impressionists and postimpressionists. Many art movements appeared during the early 1900's. Each lasted only a few years but added to the richness and variety of modern art. As time passed, painters of the 1900's increasingly emphasized purely visual impact rather than recognizable subject matter or storytelling.

**Fauvism** was the first important art movement of the 1900's. The fauves flourished as a group only from about 1903 to 1907, but their style greatly influenced many later artists. Henri Matisse led the movement, and other fauves included André Derain, Raoul Dufy, Georges Rouault, and Maurice de Vlaminck, all of France.

The fauves did not attempt to express ethical, philosophical, or psychological themes. Most of these artists, including Matisse, tried to paint pictures of comfort, joy, and pleasure. The fauves used extremely bright colours and even painted objects in colours quite different from their natural colours. To a fauve, for example, a tree trunk need not be brown. It could be bright red, purple, or any other colour. Matisse's *Landscape at Collioure,* on this page, shows the fauve fascination with bright, pure colours, and bold, flat patterns.

**Cubism** began in 1907 and became one of the most influential movements in modern art. The leading cubists were Georges Braque of France and Pablo Picasso of Spain. Other cubists included Juan Gris of Spain and Robert Delaunay and Fernand Léger of France.

The cubists reacted against traditional methods of portraying reality. They rejected emotion and storytelling and avoided emphasizing atmosphere, light, and perspective. The cubists were concerned with how to represent form in painting. They wanted to show forms in their basic geometrical shapes. To do this, the cubists included several views of a subject in the same painting. The cubists also tried to create three-dimensional forms on the flat painting surface.

Paul Cézanne's works played an important part in the development of cubism. Compare Braque's early cubist landscape *Road near L'Estaque* (page 81) with the landscape reproduced in **Cézanne, Paul.** Cézanne's influence can be seen in Braque's brushstrokes, colours, and geometrical portrayal of hills, road, and trees.

Cubism passed through two important phases. The first, called *analytical* cubism, lasted from 1910 to 1912. During this period, cubists explored subjects in terms of pure form. The artist mentally broke up the subject into many flat planes and then arranged the planes in a painting in complex interlocking and overlapping relationships. In analytical cubism, artists used sober colours, especially browns and greys. Picasso's portrait *Ma Jolie* (page 80) is an example of the style.

The second phase of cubism, called *synthetic* cubism, began in about 1912. By that time, cubist artists had gained confidence in their ability to handle the style. They used brighter colours and a broader variety of shapes and textures. They continued to stress geometri-


The Museum of Modern Art, New York City, acquired through the Lillie P. Bliss Bequest

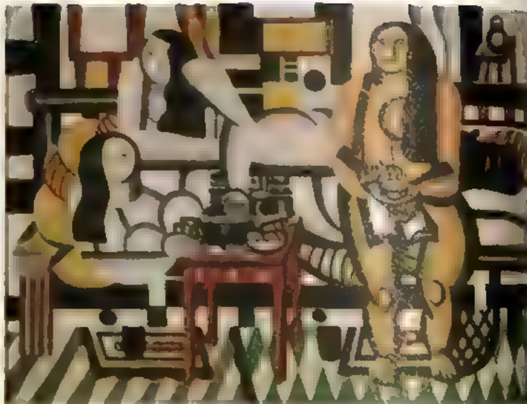
*Ma Jolie* by Pablo Picasso
1912. Oil on canvas. 100 by 65 cm.

cal planes, but used larger, more varied planes.

Gris painted the first important synthetic cubist works. In *The Bottle of Anis del Mono* (page 81), he portrayed several views of the subject—a bottle of liqueur on a slanted wooden table. Gris indicated the bottle by reproducing the appearance of the glass and pieces of a label. He identified the table through some painted wood grain. To increase the richness of the work's form and texture, Gris pasted bits of paper onto the surface of the canvas. The addition of paper or other material onto a painting's surface is called *collage*.

Delaunay believed that pure colour is the essential element of painting. He developed a branch of cubism called *orphism*. In paintings such as *Circular Forms*, on this page, Delaunay retained the geometrical patterns of cubism. But he used much brighter colours than other cubists did and he avoided showing any recognizable subject matter. *Circular Forms* thus ranks as one of the first abstract paintings of modern art.

Léger began as a cubist, but by about 1917, he had developed a personal style that reflected his fascination with modern industrial life. Léger used metallic colours and machinelike forms—pipes, rods, and tubes—in such compositions as *Three Women*, which is reproduced on this page. The painting shows cubist influences in its



The Museum of Modern Art, New York City Mrs. Simon Guggenheim Fund

*Three Women* by Fernand Léger
1921. Oil on canvas. 1.84 by 2.51 m.

geometrical patterns and in its rearrangement of forms.

**Futurism** developed in Italy at about the same time that cubism appeared in France. Futurist painters wanted their works to capture the speed and force of modern industrial society. Their paintings glorified the mechanical energy of modern life. Subjects included cars, motorcycles, and trains. Umberto Boccioni's *The City Rises* (page 82) expresses the explosive vitality of a modern city. Other leading futurists included Giacomo Balla, Carlo Carrà, and Gino Severini.

**Expressionism** was an art movement that developed in Germany. It included both German and non-German artists. Expressionist ideas about painting contrasted sharply with those of the impressionists and the fauves. Impressionist artists tried to capture the part of the real world that they could see at a glance. The expressionists distorted reality to express highly personal views of the world. The fauves used colour to show a happy world of light and pleasure. Many expressionists used colour to show a world of intense and painful emotions.

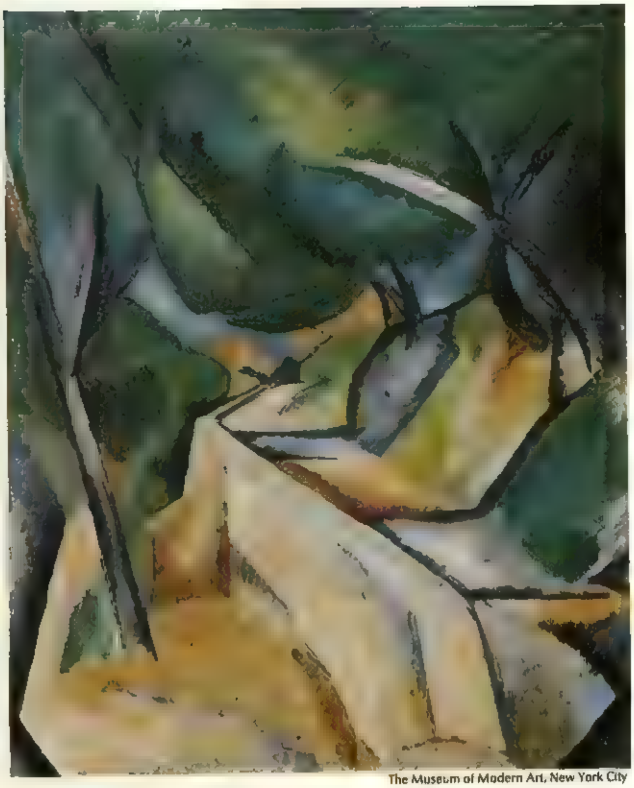
German expressionism developed in two separate movements—*Die Brücke*, which lasted from 1904 to 1913, and *Der Blaue Reiter*, which lasted from 1911 to

The Solomon R. Guggenheim Museum Collection, New York City

*Circular Forms* by Robert Delaunay
About 1912. Oil on canvas. 1.29 by 1.95 m.


Collection of Herbert and Nannette Rothschild

*The Bottle of Anis del Mono* by Juan Gris
1914. Oil, crayon, and collage on paper mounted on canvas.
42 by 24 cm.



The Museum of Modern Art, New York City

*Road near L'Estaque* by Georges Braque
1908. Oil on canvas.
60 by 50 cm.

1914. *Die Brücke* (The Bridge) began in Dresden. Its most important painters included Erich Heckel, Ernst Ludwig Kirchner, Emil Nolde, and Karl Schmidt-Rottluff. The Norwegian artist Edvard Munch had a major influence on *Die Brücke*.

Munch concerned himself with an inner world symbolized by disappointed love, fear, hatred, sickness, and death. His works have a gloomy tone that became a distinguishing characteristic of *Die Brücke* art. *Die Brücke* artists used thick, pure colours and enclosed them with heavy outlines. Their works show restlessness, unhappiness, and discontent with social conditions.

*Der Blaue Reiter* (The Blue Rider) was formed in Munich. Members of the movement included August Macke and Franz Marc of Germany, Alexis von Jawlensky and Wassily Kandinsky of Russia, and Paul Klee of Switzerland. *Der Blaue Reiter* artists painted poetic and symbolic pictures that differed from the scenes of emotional suffering and social criticism painted by *Die Brücke* artists. Each painter in *Der Blaue Reiter* developed an individual style. But they all believed that colour and shape alone could produce emotions in a painting. Kandinsky's *Little Pleasures, No. 174* (page 82) shows this dependence on the emotional impact of colour and shapes. Klee developed a delicate, witty style to communicate his feelings about many subjects. His *Red Balloon* (page 82) is typical of his charming and individual style.

Max Beckmann was a German artist who did not belong to either *Die Brücke* or *Der Blaue Reiter*. However, his works reflect the expressionist sense of disappointment and awareness of human weakness. Beckmann's *Self Portrait in a Tuxedo* (page 84) reveals the cynical attitude common among German artists of the 1920's.

**Dadaism,** an international movement, was formed in Zurich, Switzerland, in 1916. The leading dadaists included Jean Arp of France, Hans Richter of Germany, and Tristan Tzara of Romania. The dadaists rebelled against the self-satisfaction they saw in European life. They were angered by the destruction caused by World War I and believed the world was destroying itself.

Marcel Duchamp did not belong to the Swiss dada group, but his attitude toward art represents the dada philosophy. He believed that life is absurd and that the traditional standards of art were meaningless. In such works as the *Chocolate Grinder, No. 1* (page 83), he portrayed everyday objects to mock the idea that art is eternal or deep. He implied that it resembles junk.

**Amedeo Modigliani** did not belong to any movement. Nearly all his works are portraits. Most of them consist of a single figure who shows little expression. The figures have unnaturally long features. *Gypsy Woman with Baby* (page 84) is typical of his style.

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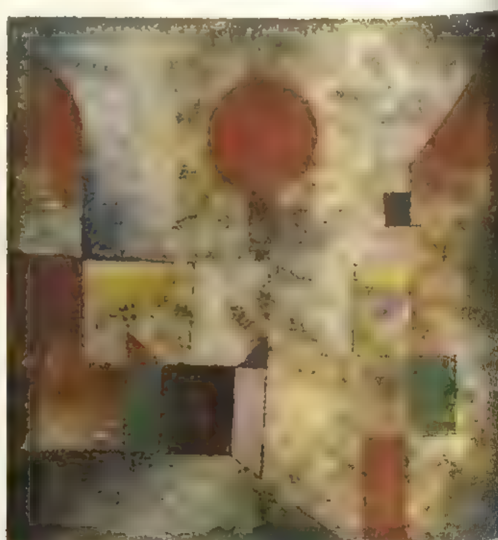
*The City Rises*
by Umberto Boccioni
1910. Oil on canvas. 1.99 by 3.01 m.

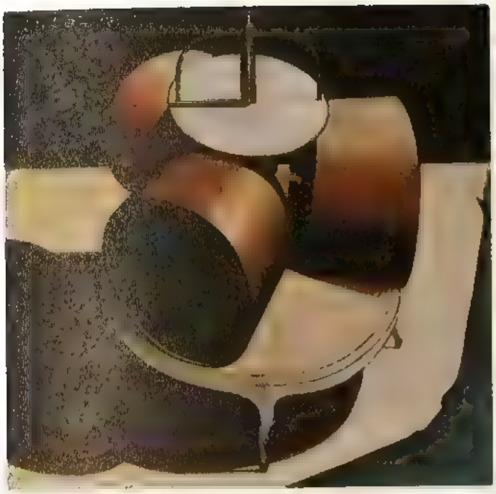
The Solomon R. Guggenheim Museum Collection, New York City

*Little Pleasures, No. 174*
by Wassily Kandinsky
1913. Oil on canvas.
110 by 120 cm.



The Solomon R. Guggenheim Museum Collection, New York City

*Red Balloon*
by Paul Klee
1922. Oil on chalk-primed muslin mounted on a board. 32 by 31 cm.



Philadelphia Museum of Art,
the Louise and Walter Arensberg Collection

*Chocolate Grinder, No. 1* by Marcel Duchamp
1913. Oil on canvas. 63 by 65 cm.


Roy R. Neuberger Collection, New York City

*The Barber Shop* by Stuart Davis
1930. Oil on canvas. 89 by 109 cm.

**Surrealism** was a movement founded in Paris in 1924 by a group of artists, philosophers, and writers. The movement resembled dadaism in its opposition to the attitudes and customs of European society. But the dadaists created works within a framework of everyday life, and the surrealists tried to find a new reality. The surrealists believed they could discover this reality by exploring the subconscious mind.

Surrealism developed into two main schools. One school included Giorgio de Chirico of Italy, Salvador Dali of Spain, and Paul Delvaux and René Magritte of Belgium. These artists tried to produce new sensations in the mind of the viewer by placing contradictory images next to each other in their paintings. Some of these images were commonplace, and others were fantastic and dreamlike. The artists painted their pictures so that the images seemed to lie in deep space. The results were mysterious paintings that seemed to have no logical explanation. The painters added to the feeling of mystery by giving their works unusual titles. An example of this branch of surrealism is Dali's *Gala and the Angelus of Millet Immediately Preceding the Arrival of the Conic Anamorphoses* (page 85).

The other school of surrealism practised a method of painting called *automatism.* Max Ernst of Germany and André Masson of France became the leading artists of this school. The followers of automatism believed that painters should free themselves from the conscious process of creation. They tried to let their brushes move freely to let their subconscious minds create their works. They believed that the images and symbols produced in this way reveal the soul of the artist. Masson's *Battle of Fishes* (page 84) is an automatic painting.

Joan Miró, a Spanish surrealist, developed a distinct style. Miró's *Landscape* (page 85) shows the simplicity and wit of his art. But it is typically surrealistic in its fantastic, imaginative images.

**Piet Mondrian,** a Dutch artist, developed an extremely simplified abstract style. Like other abstract painters, he rejected recognizable subject matter. Mondrian also ignored texture in his works. He reduced painting to straight lines meeting at right angles. He used only black, white, grey, and the primary colours. Mondrian's *Lozenge Composition in a Square* (page 86) illustrates his approach to painting. This style influenced modern commercial art and industrial design.

**Mexican painting** reached a high point in the 1920's and 1930's, when several artists painted subjects stressing nationalistic feelings. Mexican artists combined the techniques of expressionism with nationalistic and, sometimes, revolutionary themes. José Clemente Orozco, Diego Rivera, David Siqueiros, and other Mexican painters tried to create uniquely Mexican works. Many of their paintings portray Mexican heroes and history. Such works were in demand for decorating public buildings, and so many Mexican artists turned to painting enormous murals. Rivera's *Agrarian Leader Zapata* (page 86) is part of a mural based on the life of the Mexican revolutionary hero Emiliano Zapata. Orozco mixed Mexican Aztec myth with modern industrial themes in his *An Epic of American Civilization* (page 40).

**American painting—1900-1940.** In 1908—the year that cubism appeared in Europe—a group of American artists exhibited together. They were called *the Eight.* Robert Henri led the group, and the other members were Arthur B. Davies, William Glackens, Ernest Lawson, George Luks, Maurice Prendergast, Everett Shinn, and John Sloan. Each had his own style. But these artists were united in their opposition to the conservative, sentimental American painting that was fashionable in the early 1900's. They believed that American art should reflect modern life. Some members of the Eight painted realistic street scenes and pictures of people at the beach and at prizefights. Such pictures caused some

Courtesy of the Busch-Reisinger Museum, Harvard University, Cambridge, Massachusetts, U.S.A.

*Self Portrait in a Tuxedo* by Max Beckmann
1927. Oil on canvas. 1.38 by 0.96 m.

National Gallery of Art, Washington, D.C. Chester Dale Collection

*Gypsy Woman with Baby* by Amedeo Modigliani
1919. Oil on canvas. 116 by 73 cm.

The Museum of Modern Art, New York City

*Battle of Fishes* by André Masson
1927. Oil, pencil, and sand on canvas. 36 by 73 cm.

Henry P. McIlhenny Collection, Philadelphia

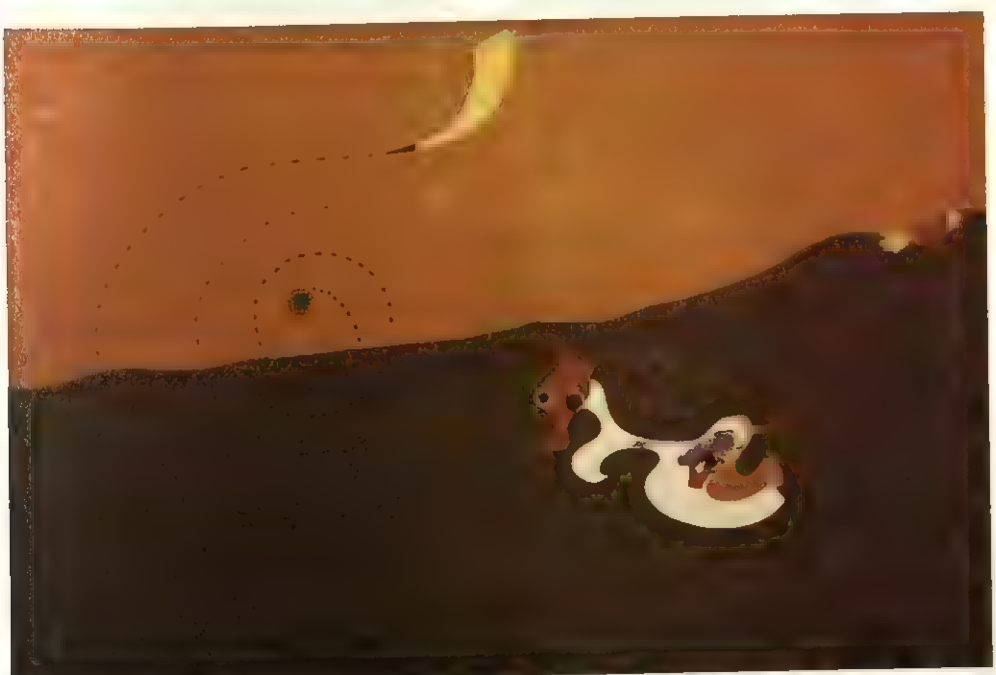
*Gala and the Angelus of Millet Immediately Preceding the Arrival of the Conic Anamorphoses*
by Salvador Dali
1933. Oil on wood. 24 by 19 cm.

critics to call this American group the *Ashcan School.*

The art movements that developed in Europe during the early 1900's influenced many American painters. Several American artists travelled to Europe and met the painters who were changing the course of modern art. Max Weber studied with Matisse and the cubists in Europe from 1905 to 1908. He then returned to the United States and painted some of the earliest abstract paintings in American art. After trips to Europe, Charles Demuth and Charles Sheeler used cubist styles to portray the simple geometrical shapes they saw in American city and industrial landscapes.

The American public got its first thorough look at modern art in 1913 at a famous exhibit called the Armory Show. This show opened in New York City and then travelled to Chicago and Boston, Massachusetts. Arthur B. Davies headed a committee of American artists that organized the show. The exhibit included works by cubists, fauves, German expressionists, and postimpressionists, as well as works by young experimental American artists. Many American artists who attended the show changed their styles to reflect the new European movements that were beginning to revolutionize modern painting.

Stuart Davis studied with Robert Henri and exhibited in the Armory Show. After visiting Europe in the 1920's, Davis developed a style that combined American subject matter with cubist geometrical forms. *The Barber Shop* (page 83) shows the lively colours, cubist arrangement of forms, and everyday American subject matter that characterizes Davis' work.



The Solomon R. Guggenheim Museum Collection, New York City

*Landscape* by Joan Miró
1927. Oil on canvas. 1.3 by 1.95 m.

*Lozenge Composition in a Square* by Piet Mondrian
1925. Oil on canvas.
102 by 102 cm.

The Museum of Modern Art, New York City

*Agrarian Leader Zapata* by Diego Rivera
1931. Fresco.
2.38 by 1.88 m.

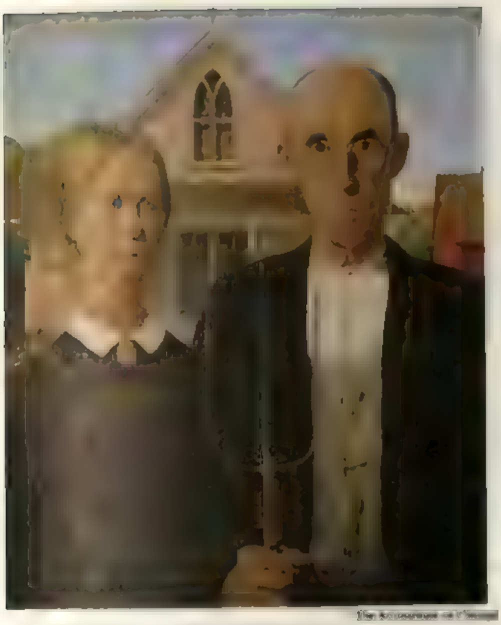
During the 1930's, some American painters turned to themes taken from specific regions of the United States. Thomas Hart Benton and Grant Wood painted Midwestern landscapes, folk tales, and legends in an attempt to create a completely American kind of painting. Wood's *American Gothic* (page 87) portrays the architecture, landscape, and people of the Midwest in 1930. Edward Hopper found his subjects in large American cities. Hopper's *Nighthawks,* on this page, illustrates the loneliness and feeling of isolation the artist saw in American big-city life.

**Abstract expressionism.** During the 1930's and after World War II began in 1939, many famous European painters moved to the United States. They included Max Ernst, Hans Hofmann, Fernand Léger, André Masson, and Piet Mondrian. These artists settled in New York City and influenced many young American painters there. By 1943, the mingling of the older European masters with the younger American painters had produced the most significant movement in modern American painting—abstract expressionism.

Scholars divide abstract expressionism into two schools—*action painting* and *field painting.* The leading action painters were Jackson Pollock and Willem de Kooning. The action painters believed that painting should be a natural act of free expression. For them, the most important aspect of art was the physical creation of the painting. Pollock laid his canvas flat on the floor and dribbled and splattered paint on the surface as he moved around it. His finished pictures were masses of forms weaving across the canvas. His painting *Number 13, 1949,* is reproduced in the article United States (Art).

The Art Institute of Chicago

*Nighthawks*
by Edward Hopper
1942. Oil on canvas.
84 by 153 cm.



The Art Institute of Chicago

*American Gothic* by Grant Wood
1930. Oil on beaverboard. 76 by 63 cm.

De Kooning also painted abstract pictures with swirling masses of lines. But some of his works have recognizable subject matter. These paintings include a famous series of savage portraits of women.

The field painters, or *imagists,* were led by Barnett Newman and Mark Rothko. They restricted themselves to simple, luminous expanses of closely related colours. Morris Louis was a field painter who first became well known during the 1950's. In creating his *Blue Veil,* which is reproduced on page 45, Louis stained the colour into his canvas instead of applying it with a brush. The colour thus became an actual part of the painting surface.

**Andrew Wyeth** was probably the most popular American painter of the mid 1900's. He painted in the realistic tradition at a time when most leading American painters were creating abstract works. Wyeth painted precisely detailed scenes of rural Maine and Pennsylvania. His *Albert's Son* appears on page 43.

**Pop art** was a movement that began in the United States during the late 1950's. The leading pop artists included Jasper Johns, Roy Lichtenstein, Robert Rauschenberg, and Andy Warhol. This movement developed partly as a reaction against abstract expressionism's emphasis on nonrepresentational art and its personal involvement of the artist. The pop artists built their works around such common objects as road signs, soup can labels, newspaper photographs, and soft-drink bottles. They reproduced the objects with almost photographic precision and avoided expressing any emotional point of view. For example, Lichtenstein's painting *Blam* (shown below) looks like a reproduction in enlarged form of a panel from a comic strip.

**Postwar European painting.** During the late 1940's and 1950's, the United States largely replaced Europe as the centre of Western painting. Many European artists adopted the abstract expressionist and pop art styles first developed in America. However, several original painters appeared in postwar Europe.

The English artist Francis Bacon developed a portrait style of terrifying strangeness by blending elements of cubism, surrealism, and expressionism. An example is his *Portrait of Pope Innocent X* (page 32). Jean Dubuffet, a French painter, was influenced by the art of ordinary people instead of by the sophisticated works of professional artists. Dubuffet's *Business Prospers* (shown below) has the appearance of drawings created by a child, an amateur artist, or someone who scrawled on a wall.

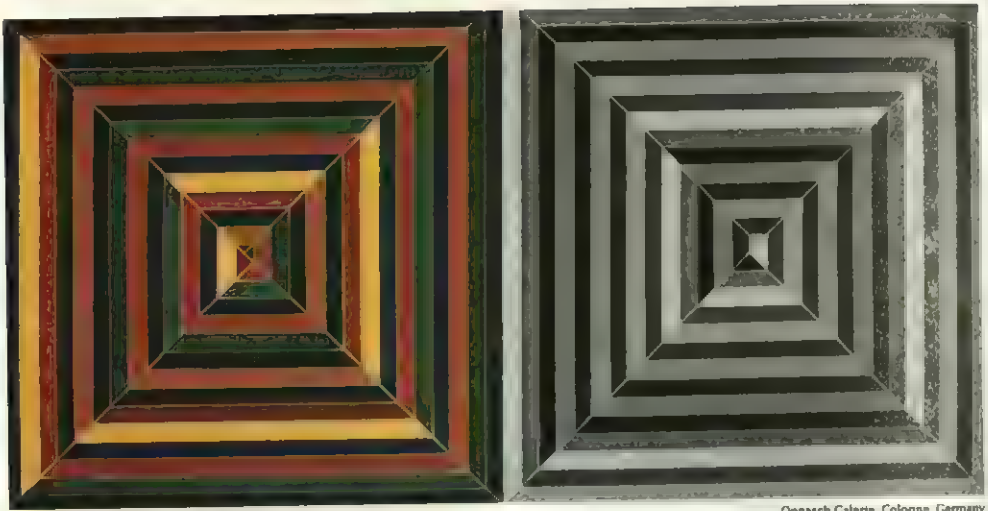
A movement called *op art,* or *optical art,* emphasized pure abstraction. It originated in France and spread to the United States during the 1950's. Op art consists of carefully arranged colours and geometrical patterns that create optical illusions of vibrating movement on the painting's surface.


Richard Brown Baker Collection, New York City

*Blam* by Roy Lichtenstein
1962. Oil on canvas
1.73 by 2.03 m.

The Museum of Modern Art, New York City. Mrs. Simon Guggenheim Fund

*Business Prospers* by Jean Dubuffet
1961. Oil on canvas
1.65 by 2.20 m



Onnasch Galerie, Cologne, Germany

*Jasper's Dilemma* by Frank Stella
1963. Alkyd on canvas. 1.96 by 3.91 m.

**Minimal art** developed in the United States in the 1960's. Minimal artists believe that a painting should be an object with no emotional content, or references to subject matter, personal meanings, or symbolic interpretations. Frank Stella's *Jasper's Dilemma,* above, is a minimal painting. In this work, the artist reduced his subject to a composition of colour, form, and shape.

During the 1970's, many American painters continued to use the minimal style that appeared in the 1960's. But new approaches to painting have largely replaced abstract expressionism, op art, pop art, and other leading styles of the 1950's and 1960's.

Some artists combine traditional oil-painting techniques with actual objects rather than with painted representations of those objects. These artists use such materials as aluminium, plastics, and wood. Many painters introduce actual mass and space into their works instead of the illusion of mass and space. For example, some artists include machines and mechanical lights that create movement. A few artists sometimes use fluorescent lights to outline forms in their pictures. Some painters use a *shaped canvas,* which sticks out into space.

Some artists follow a style called *new realism.* They represent objects with almost photographic exactness. Unlike earlier realists, many new realists deliberately avoid expressing a point of view in their paintings. Many of their subjects are mass-produced commercial products.

Robert Bechtle's *60 T-Bird* (page 31) is a good example of new realism. Bechtle clearly and carefully painted his subject matter—a man standing near a car. But the painting tells little about what the artist felt or thought about his subject. The viewer cannot tell whether Bechtle intended (1) to glorify the role the car plays in the United States, (2) to mock people for the importance they give to the car, or (3) simply to record a scene from everyday life.

Other artists paint extremely realistic pictures that achieve an almost abstract effect. In the picture *Hilo,* reproduced on the left, Joseph Raffael painted a realistic study of water lilies floating on the surface of a pond. However, the viewer sees the painting, not as a portrait of familiar natural forms, but as colours, shapes, and textures. Earlier abstract artists would have invented nonrepresentational forms to express similar qualities.



*Hilo* by Joseph Raffael
1975. Oil on canvas. 2.29 by 1.68 m.

Many artists express their opposition to discrimination, poverty, and war through their works. Artists from minority groups, especially black artists, have painted the walls of buildings in some cities. These pictures often express the artists' discontent with society and their pride in their racial heritage. A typical example is the *Wall of Love* by William Walker (page 35).

Some art critics say that too much of today's painting is concerned only with originality and novelty. They agree that artists should discard traditions that no longer meet their needs. But they point out that most great advances in style and technique were achieved because artists believed they needed new methods to express beliefs or ideas. However, originality for its own sake becomes boring unless the painting has qualities that help it remain significant and interesting after its novelty has worn off.

## *Study aids*

**Related articles** in *World Book.* See the *Arts* section of the longer country articles, such as **France** (Arts). Many of the following biographies include examples of the artist's work. Paintings also appear in many other articles. There are cross-references in the painters' biographies to these articles. For example, there is a cross-reference in the **Leonardo da Vinci** biography to one of his paintings in the **Jesus Christ** article.

**American painters**

Albright, Ivan
Bellows, George W.
Benton, Thomas Hart
Bierstadt, Albert
Bingham, George Caleb
Blakelock, Ralph A.
Cassatt, Mary
Catlin, George
Chase, William M.
Church, Frederick E.
Copley, John Singleton
Curry, John Steuart
Davis, Stuart
De Kooning, Willem
Eakins, Thomas
Frankenthaler, Helen
Gorky, Arshile
Gottlieb, Adolph
Graves, Morris
Hicks, Edward
Hofmann, Hans
Homer, Winslow
Hopper, Edward
Inness, George
Kent, Rockwell
Lawson, Ernest
Leutze, Emanuel G.
Levine, Jack
Marin, John
Morse, Samuel F. B.
Moses, Grandma
Motherwell, Robert
O'Keeffe, Georgia
Parrish, Maxfield
Peale (family)
Pollock, Jackson
Prendergast, Maurice B.
Rauschenberg, Robert
Remington, Frederic
Rockwell, Norman
Rothko, Mark
Russell, Charles Marion
Ryder, Albert Pinkham
Sargent, John Singer
Shahn, Ben
Sheeler, Charles
Stella, Frank
Stuart, Gilbert C.
Sully, Thomas
Tanner, Henry O.
Tomlin, Bradley Walker
Warhol, Andy
Whistler, James A. M.
Wood, Grant
Wyeth, Andrew

**Australian painters**

Blackman, Charles
Boyd (family)
Brack, John
Buvelot, Louis
Dargie, Sir William
Daws, Lawrence
Dickerson, Bob
Dobell, Sir William
Drysdale, Sir Russell
Fairweather, Ian
French, Leonard
Gill, Samuel Thomas
Herman, Sali
Heysen, Sir Hans
Lambert, George
Martens, Conrad
McCubbin, Frederick
Namatjira, Albert
Nolan, Sir Sidney
Pugh, Clifton
Roberts, Tom
Tucker, Albert
Whiteley, Brett
Williams, Fred

**Canadian painters**

Jackson, Alexander Young
Kane, Paul
Thomson, Tom

**Chinese painters**

Chen Rong
Gu Kaizhi
Huizong
Ma Yuan
Wang Wei
Wu Daozi

**Dutch painters**

Bosch, Hieronymus
De Hooch, Pieter
Hals, Frans
Mondrian, Piet
Rembrandt
Ruisdael, Jacob van
Van Gogh, Vincent
Van Leyden, Lucas
Vermeer, Jan

**Flemish and Belgian painters**

Brouwer, Adriaen
Bruegel, Pieter, the Elder
Campin, Robert
Ensor, James
Magritte, René
Memling, Hans
Rubens, Peter Paul
Van der Goes, Hugo
Van der Weyden, Rogier
Van Dyck, Sir Anthony
Van Eyck, Jan

**French painters**

Bonheur, Rosa
Bonnard, Pierre
Boucher, François
Braque, Georges
Breton, Jules A.
Cézanne, Paul
Chardin, Jean Baptiste
Claude
Corot, Camille
Courbet, Gustave
Daumier, Honoré
David, Jacques Louis
Degas, Edgar
Delacroix, Eugène
Derain, André
Dubuffet, Jean
Duchamp, Marcel
Dufy, Raoul
Fragonard, Jean Honoré
Gauguin, Paul
Géricault, Théodore
Ingres, Jean A. D.
Laurencin, Marie
Léger, Fernand
Limbourg, Pol de
Manet, Edouard
Matisse, Henri
Millet, Jean F.
Monet, Claude
Pissarro, Camille
Poussin, Nicolas
Renoir, Pierre Auguste
Rouault, Georges
Rousseau, Henri
Seurat, Georges
Sisley, Alfred
Toulouse-Lautrec, Henri de
Utrillo, Maurice
Vigée-Lebrun, Elisabeth
Vlaminck, Maurice de
Vuillard, Edouard
Watteau, Antoine

**German painters**

Cranach, Lucas, the Elder
Dürer, Albrecht
Ernst, Max
Grosz, George
Grünewald, Matthias
Holbein, Hans, the Elder
Holbein, Hans, the Younger
Kandinsky, Wassily
Kollwitz, Käthe
Schongauer, Martin

**Italian painters**

Bellini, Gentile
Bellini, Giovanni
Bellini, Jacopo
Botticelli, Sandro
Caravaggio, Michelangelo
Chirico, Giorgio de
Cimabue, Giovanni
Correggio
Duccio di Buoninsegna
Fra Angelico
Ghirlandajo, Domenico
Giorgione
Giotto
Leonardo da Vinci
Lippi, Filippo
Mantegna, Andrea
Masaccio
Michelangelo
Modigliani, Amedeo
Piero della Francesca
Pollaiuolo, Antonio del
Raphael
Simone Martini
Tiepolo, Giovanni Battista
Tintoretto
Titian
Uccello, Paolo
Veronese, Paolo

**Japanese painters**

Hiroshige
Hokusai
Sesshu
Sharaku
Utamaro

**Mexican painters**

Orozco, José C.
Rivera, Diego
Tamayo, Rufino

**Filipino painters**

Amorsolo, Fernando
Hidalgo, Felix
Luna, Juan

**Spanish painters**

Dali, Salvador
Goya, Francisco
Greco, El
Gris, Juan
Miró, Joan
Murillo, Bartolomé Esteban
Picasso, Pablo
Ribera, Jusepe de
Velázquez, Diego
Zurbarán, Francisco

**South African painters**

Battis, Walter
Baines, Thomas
Pierneef, Jacob Hendrik
Sekoto, Gerard
Stern, Irma
Wenning, Pieter

**United Kingdom painters**

Bacon, Francis
Blake, William
Bonington, Richard P.
Constable, John
Hockney, David
Hogarth, William
Hilliard, Nicholas
Lowry, L. S.
Millais, Sir John Everett
Nicholson, Ben
Piper, John
Raeburn, Sir Henry
Reynolds, Sir Joshua
Robinson, William Heath
Spencer, Sir Stanley
Stubbs, George
Turner, J. M. W.

**Other painters**

Apelles
Bihzad, Kamal ad-Din
Chagall, Marc
Kandinsky, Wassily
Klee, Paul
Klimt, Gustav
Kokoschka, Oskar
Munch, Edvard
Sickert, Walter Richard

**Styles**

Abstract expressionism
Ashcan School
Avant-garde
Barbizon School
Baroque
Bauhaus
Byzantine art
Carolingian art
Classicism
Cubism
Dadaism
Expressionism
Fauves
Futurism
Gothic art
Group of Seven
Heidelberg School
Hudson River School
Impressionism
Islamic art
Mannerism
Pop art
Pre-Raphaelite Brotherhood
Realism
Rococo
Romanticism
Surrealism

**Other related articles**

Animal (pictures: People and animals)
Art and the arts
Australian art
Caricature
Cartoon
Collage
Dancing (picture: Prehistoric dancers)
Design
Drawing
Finger painting
Fresco
Icon
India, Art of
Japanese print
Manuscript
Mosaic
Mural
Perspective
Philippines, Art of the
Radiochemistry
Sand painting
South Africa, Art of
Stained glass
United Kingdom, Arts of the
Watercolour

**Outline**

I. **What do painters paint?**
A. People
B. Religious subjects
C. Landscapes and seascapes
D. Still lifes
E. History, mythology, and social expression
F. Painting compositions
G. Painting as decoration

II. **The elements of painting**
A. Colour
B. Line
C. Mass
D. Space
E. Texture

III. **Materials and techniques**
A. Painting materials
B. Painting supports
C. Painting grounds
D. Fresco painting
E. Watercolour painting
F. Encaustic painting
G. Pastels
H. Tempera
I. Oil paint
J. Synthetic resins

IV. **Origins and early painting**
V. **Oriental painting**
VI. **Medieval painting**
VII. **The Renaissance**
VIII. **The 1600's and 1700's**
IX. **The 1800's**
X. **The 1900's**

**Questions**

How did Masaccio influence Renaissance painting?
How do *gouache* and *tempera* paints differ?
What are the characteristics of the Ma-Hsia style of Chinese painting?
How did Paul Cézanne's paintings influence cubism?
What are five important elements in painting?
What is the major difference between a portrait by Francis Bacon and a portrait by Amedeo Modigliani?
How did Giotto's style differ from the style of Byzantine painters?
How did the *impressionists* develop a revolutionary style?
How do *baroque* and *rococo* painting differ?
What contribution did Edouard Manet make to art?

**Paisley** is a city in western Scotland located about 11 kilometres west of Glasgow. For location, see **Scotland** (political map). The city is known for the shawls it produced during the 1800's. *Paisley* is also the name of the design that imitates the pattern used on these shawls.

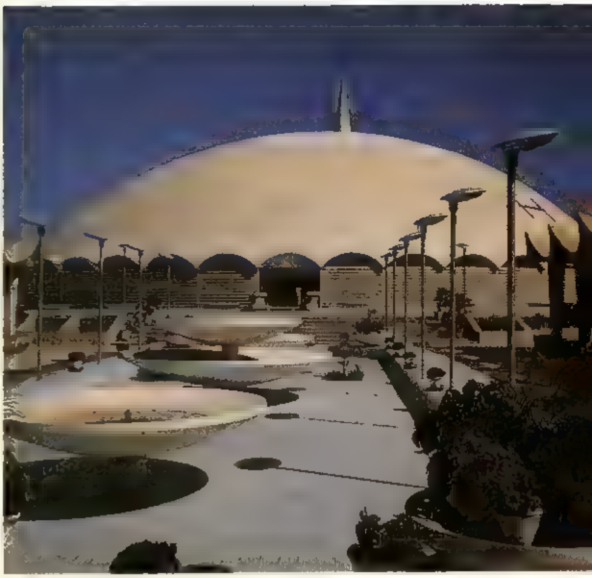
**Paisley, Ian** (1926- ), is a Northern Ireland Presbyterian minister known for his hardline support of Northern Ireland's status as a province of the United Kingdom (see **Unionist parties**). Paisley was ordained in 1946. He became moderator of the Free Presbyterian Church of Ulster in 1951.

In 1970, Paisley became the member for North Antrim in the United Kingdom (UK) Parliament. He also sat in the Northern Ireland (Stormont) Parliament (1970-1972), the Northern Ireland Assembly (1973-1974), and the Constitutional Convention (1974-1975). In 1979, he became a member of the European Parliament.

Paisley was one of the strongest opponents of power sharing between Northern Ireland's Protestants and Roman Catholics. In 1971, he founded a hardline political party, the Democratic Unionist Party. In 1974, he helped support a Protestant strike that brought down Brian Faulkner's Northern Ireland Executive. In 1985, the UK and Irish governments signed an agreement giving the latter consultative rights in some Northern Ireland policies. Paisley was a leading opponent of the agreement.

**Pak Sako.** See **Ishak, Haji Muhamad.**

**Most Pakistani cities and towns** have outdoor market places called *bazaars,* where shoppers can buy food, clothing, and other products. Some business people, such as the silk merchant shown above, display their goods on the ground.



**Islam is the religion** practised by most Pakistanis. Religion forms an important link between the different cultural groups of Pakistan. Prayers and other religious rituals take place at mosques like the military mosque, *above,* in Karachi.

# Pakistan

**Pakistan** is a Muslim nation in southern Asia. The country's official name is the Islamic Republic of Pakistan. About 97 per cent of its people practise Islam, the Muslim religion. Religion was the chief reason for the establishment of Pakistan as an independent nation.

During the 1800's and early 1900's, Great Britain ruled the region that is now Pakistan. The region formed part of India, an important part of the British Empire. When the British granted India independence in 1947, they divided the country according to the religion of its people. Pakistan was created out of northwestern and northeastern India. The two sections of the new nation were over 1,600 kilometres apart. The majority of the people of both regions of Pakistan were Muslims. Most of the people of the remaining territory of India were Hindus. The partition of India resulted in great upheavals as people crossed from one country to the other.

The two sections of Pakistan were called West Pakistan and East Pakistan. Although the people of both regions shared the same religion, many differences divided them. These differences led to civil war in 1971 and to the establishment of East Pakistan as an independent nation called Bangladesh. For information on the region that was formerly East Pakistan, see the *World Book* article on **Bangladesh.**

Cultural differences remain a problem in Pakistan today. The population consists of a number of cultural groups, each with its own language. The official language of Pakistan is Urdu, but large parts of the population speak only Baluchi, Punjabi, Pushtu, or Sindhi. Such language barriers, plus other divisions among its people, have made it difficult for Pakistan to develop into a unified nation.

Most Pakistanis are farmers or herders with little or no education. Many of them live much as their ancestors did hundreds of years ago. Traditional attitudes and customs do not have so great an influence over everyday life among Pakistan's educated people. Most of these people live in the cities.

Pakistan has towering snow-capped mountains, high plateaus, fertile plains, and sandy deserts. Most Pakistanis live in the irrigated plains region of eastern Pakistan. The greatest concentration of population is in the Punjab, a fertile plain in the northeast. Islamabad, the nation's capital, lies in this area. Much of the western part of the country is lightly settled because the area is too dry and barren for farming.

The history of the region that is now Pakistan started at least 4,500 years ago, when an advanced civilization developed in the Indus Valley. This civilization lasted about 800 years and then declined and disappeared. For the next several thousand years, a number of peoples invaded and settled in what became Pakistan. Arabs, Greeks, Persians, Turks, and other invaders ruled the region before it came under the control of Great Britain in the 1800's. The complex history of Pakistan helps explain the variety that exists among the country's population today.

## Government

**Government offices** of Pakistan, *left*, are located in Islamabad. Pakistan's National Assembly buildings are part of this complex. Islamabad was designated to replace Karachi as Pakistan's capital in 1959 and was built during the 1960's.

© Robert Harding Associates from Peter Arnold

**National government.** Pakistan's Constitution was adopted in 1973. A prime minister heads the country's government, and a president serves as head of state. The prime minister appoints a Cabinet to help run the government. The president's powers include the ability to dismiss the prime minister and Cabinet and to dissolve the National Assembly. The parliament consists of a National Assembly and a Senate. Most members of the National Assembly are elected by the people. Most senators are elected by provincial assemblies.

**Provincial government.** Pakistan is divided into four provinces—Baluchistan, North-West Frontier Province (NWFP), the Punjab, and Sind. An elected assembly governs each province.

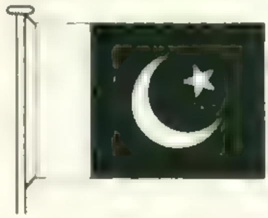
**Local government.** Elected and appointed officials govern cities, towns, and villages. Islamabad, the nation's capital, is governed by the central government as a separate district called the Capital Territory of Islamabad. Certain parts of Pakistan that border Afghanistan are called *Tribal Territories.* The central government has authority over these territories, but members of the various tribal groups handle most of their own governmental affairs.

**Court system.** The court system of Pakistan is made up of civil, criminal, and appeals courts. The Supreme Court of Pakistan is the nation's highest court. A High Court heads the court system in each province.

### Facts in brief about Pakistan

**Capital:** Islamabad.
**Official name:** The Islamic Republic of Pakistan.
**Official language:** Urdu.
**Area:** 796,095 km². *Greatest distances*— north-south, 1,505 km; east-west, 1,287 km. *Coastline*—814 km.
**Elevation:** *Highest*—K2 (in Kashmir), 8,611 m above sea level. *Lowest*—sea level.
**Population:** *Estimated 1996 population*—138,672,000; density, 174 people per km²; distribution, 65 per cent rural, 35 per cent urban. *1981 census*—84,253,644. *Estimated 2001 population*—158,726,000.
**Chief products:** *Agriculture*—wheat, cotton, rice, sugar cane, milk, chickpeas. *Manufacturing*—cotton textiles and clothing, food products, fertilizer, steel, cement. *Mining*—natural gas, petroleum.
**National anthem:** "Qaumi Tarana" ("National Anthem").
**Money:** *Currency unit*—Pakistani rupee. One rupee = 100 paisas.

**Armed forces.** Pakistan's armed forces consist of an army of about 450,000 members and a small navy and air force. All the people who serve in the armed forces are volunteers.



**Pakistan's flag** has a star and crescent, traditional symbols of Islam. Green stands for the nation's Muslim majority.

**Coat of arms.** A wreath of narcissus, the national flower, encircles a shield on the Pakistani coat of arms.


**Pakistan** lies in southern Asia. It is situated to the north-west of India and covers an area of almost 800,000 km².

## People

The earliest people of what is now Pakistan belonged to the same population group as the people of northern India. Through the years, many invaders intermarried with the inhabitants. These invaders included Arabs, Afghans, Greeks, Persians, and Turks. All contributed to the mixed ancestry of present-day Pakistanis.

**Cultural groups and languages.** A number of cultural groups live in various parts of Pakistan. Each has its own customs and characteristics. Differences among the groups have caused problems throughout Pakistan's history. Some Pakistanis feel greater loyalty to their own cultural group than to the nation itself.

Language is the chief difference that divides the cultural groups. Urdu is Pakistan's official language, but less than 10 per cent of the people speak it as their primary language. Each cultural group has its own language or *dialect* (local form of a language). Most Pakistanis who know Urdu use it only as a second language.

The Punjabis, who make up the largest cultural group, live mainly in the Punjab. They speak various dialects of the Punjabi language. Through the years, they have controlled the government, economy, and armed forces of Pakistan. Other leading groups, in order of size, include the Sindhis, the Pushtuns, and the Baluchi. The Sindhis form most of the population of Sind Province. Their language is also called Sindhi. The Pushtuns are divided into various tribes that occupy the North-West Frontier Province and the northern part of the province of Baluchistan. The Pushtun language is called Pushtu or Pashto. The Baluchi include many nomadic tribes that live near oases and along a few streams in Baluchistan. They speak Baluchi, which has many dialects.

**Various cultural and language groups** live in Pakistan. Punjabis, such as the woman above, form the largest group. The man is a Pushtun from the North-West Frontier Province.

**Muslim rituals,** such as group prayer meetings, play an important part in the everyday lives of most Pakistanis. About 97 per cent of the nation's people are Muslims.

Another cultural group in Pakistan is made up of large numbers of refugees from neighbouring Afghanistan. These people fled to Pakistan in the 1980's after the Union of Soviet Socialist Republics (U.S.S.R.) invaded Afghanistan.

**Rural life.** About two-thirds of the people of Pakistan live in rural villages. Most of the villagers are farmers or herders. Many others who live in rural areas have jobs in nearby cities or towns. Traditional customs and beliefs have a strong influence on life in rural Pakistan. For example, men have far more social freedom than women do. Women avoid contact with men outside their family, and they cover their face with a veil in the presence of strangers. Women may help with farm work, but they do little else outside the home.

Housing and clothing vary from one region to another, depending on climate, local customs, and other factors. Most of the rural villages consist of clusters of two- or three-room houses made of clay or sun-dried mud. A typical home may have a few pieces of simple furniture, with straw mats covering the bare earth floors. Few rural homes have plumbing or electricity.

The most common garment of both men and women is the *shalwar-qamiz,* which consists of loose trousers and a long overblouse. Women may wear a *dupatta* (scarf) over their shoulders and head. Outside the home, women usually cover themselves with a tentlike garment called a *burqa.* In the Punjab, men may wear a skirtlike garment called a *lungi* instead of a shalwar-qamiz. Turbans or various types of woollen or fur caps are popular head coverings among Pakistani men.

**City life.** Pakistan has 12 cities with more than 200,000 people. Karachi, the largest city, has about 5 million people. See the separate articles on Pakistani cities listed in the *Related articles* at the end of this article.

Most city people in Pakistan are factory workers, shopkeepers, or craftworkers. They have little or no education and live in small houses in old, crowded neighbourhoods. Their customs resemble those of the rural villagers. Pakistan's urban population also includes educated middle- and upper-class people who have adopted many Western styles and ideas. A well-to-do Pakistani family may live in a large, modern home. Many middle-and upper-class women are active in politics, social work, and women's rights movements.


## Pakistan map index

### Cities and towns

| | | | |
|---|---|---|---|
| Abbottabad | 32,188 | B | 6 |
| Ahmadpur East | 56,979 | E | 5 |
| Arifwala | 43,654 | D | 6 |
| Bahawalnagar | 74,533 | E | 6 |
| Bahawalpur | 180,263 | E | 6 |
| Bannu | 35,170 | C | 5 |
| Bhakkar | 41,934 | D | 5 |
| Bhera | 29,654 | C | 6 |
| Chakwal | 43,670 | C | 6 |
| Charsadda* | 62,530 | B | 6 |
| Chichawatni* | 50,241 | D | 5 |
| Chiniot | 105,559 | D | 6 |
| Chishtian Mandi | 61,959 | E | 6 |
| Dadu | 39,298 | F | 4 |
| Daska* | 55,555 | C | 7 |
| Dera Ghazi Khan | 102,007 | E | 5 |
| Dera Ismail Khan | 64,358 | D | 5 |
| Gilgit | | B | 7 |
| Gojra | 68,000 | D | 6 |
| Gujar Khan | 33,920 | C | 7 |
| Gujranwala | 637,591 | C | 7 |
| Gujrat | 155,058 | C | 7 |
| Hafizabad | 83,464 | C | 7 |
| Harunabad | 42,590 | E | 6 |
| Hasilpor* | 37,026 | E | 6 |
| Hyderabad | 751,529 | G | 4 |
| Islamabad | 204,364 | C | 6 |
| Jacobabad | 79,365 | E | 4 |
| Jalapur | 29,590 | C | 7 |
| Jaranwala* | 69,459 | D | 6 |
| Jhang Maghiana | 195,558 | D | 6 |
| Jhelum | 92,646 | C | 7 |
| Kahror Pakka | 35,600 | E | 6 |
| Kamalia | 61,107 | D | 6 |
| Kamoke* | 71,097 | D | 7 |
| Karachi | 5,208,170 | G | 4 |
| Kasur | 155,523 | D | 7 |
| Khairpur | 61,447 | F | 4 |
| Khanewal | 89,090 | D | 6 |
| Khanpur | 70,589 | E | 5 |
| Khushab | 56,274 | C | 6 |
| Kohat | 55,832 | C | 6 |
| Kot Addu | 37,479 | D | 5 |
| Kotri | 39,390 | G | 4 |
| Lahore | 2,952,689 | D | 7 |
| Lala Musa | 46,626 | C | 7 |
| Larkana | 123,890 | F | 4 |
| Leiah | 51,482 | D | 6 |
| Lyallpur | 1,104,209 | D | 6 |
| Mailsi* | 33,652 | E | 6 |
| Mandi Bahauddin* | 44,796 | C | 7 |
| Mandi Burewala | 86,311 | D | 6 |
| Mardan | 141,842 | B | 6 |
| Mian Channun* | 40,609 | D | 6 |
| Mianwali | 59,159 | C | 6 |
| Mingaora* | 88,078 | B | 6 |
| Mirpur Khas | 124,371 | G | 4 |
| Mitha Tiwana* | 28,959 | C | 6 |
| Multan | 736,925 | D | 6 |
| Muzaffarabad | | B | 7 |
| Muzaffargarh | 53,192 | D | 6 |
| Nankana Sahib* | 32,963 | D | 7 |
| Narowal* | 35,125 | C | 7 |
| Nawabshah | 102,139 | G | 4 |
| Nowshera | 38,875 | B | 5 |
| Okara | 127,455 | D | 7 |
| Pakpattan | 69,820 | D | 6 |
| Peshawar | 506,896 | C | 6 |
| Quetta | 285,719 | E | 4 |
| Rahimyar Khan | 119,086 | F | 5 |
| Rawalpindi | 794,843 | C | 6 |
| Rohri | 31,332 | F | 5 |
| Sadiqabad | 63,935 | F | 5 |
| Sahiwal | 150,954 | D | 6 |
| Sangla* | 33,771 | D | |
| Sargodha | 291,362 | D | |
| Shahdadkot | 32,888 | F | |
| Shahdadpur | 42,107 | G | |
| Shekhupu[illegible] | 141,168 | D | |
| Shikarpur | 88,138 | F | |
| Shujaabad | 37,810 | E | |
| Sialkot | 302,009 | C | |
| Sukkur | 190,551 | F | |
| Swabi | 46,344 | B | |
| Tando Adam | 62,744 | G | |
| Tando Allahyar | 30,647 | C | |
| Tando Muhammad Khan | 41,757 | G | |
| Toba Tek Singh | 37,844 | D | |
| Turbat | 52,337 | G | |
| Vihari | 53,799 | D | |
| Wah | 122,335 | C | |
| Wazirabad* | 62,725 | C | |

*Does not appear on map; key shows general location.

Source: 1981 census

**Pakistani schoolchildren** attend classes outdoors in rural areas where classroom space is limited. Pakistan has a serious shortage of both schools and teachers.

**Religion.** About 97 per cent of Pakistan's people are Muslims. Islam, the Muslim religion, is the chief link among the various cultural groups that make up Pakistan's population (see **Islam**). Most Pakistanis consider prayers and other religious rituals an important part of everyday life. Muslim holidays are national holidays throughout Pakistan. Christians make up about 1½ per cent of the population. Pakistan also has a small number of Hindus, Buddhists, and Parsees.

**Food.** Wheat and other grains form the basis of the diet of almost all Pakistanis. Rural villagers use wheat flour to make flat loaves of bread called *chapatty. Pilau,* a dish served throughout Pakistan, consists of rice mixed with meat, vegetables, raisins or nuts. Most Pakistanis like foods flavoured with curry, ginger, onions, peppers, or other spicy seasonings. Popular meats include beef, chicken, goat, and lamb. Chicken eggs are a common food in many parts of the country. Islam forbids its followers to eat pork. Fresh or dried fruit is a favourite dessert.

**Education.** Only about a fourth of all Pakistanis 15 years of age or older can read and write. Less than half the children of school age go to school. Pakistan has a shortage of schools, teachers, and teaching materials, and no law requires children to attend school.

The school system consists of primary school (ages 7 to 11), middle school (ages 12 to 14), and secondary school (ages 15 and 16). After secondary school, students may go to intermediate college (ages 17 and 18), where they prepare for a college or university. Pakistan has about 20 universities. The three largest universities are the University of Karachi, the University of Peshawar, and the University of the Punjab in Lahore.

**Arts.** Each of Pakistan's cultural groups has its own folk literature, composed of stories and songs about legendary or historical figures. Rural Pakistanis enjoy plays based on myths and legends. In the cities, films are a favourite form of entertainment. Islam has influenced traditional architecture and painting throughout Pakistan (see **Islamic art**).

## Land

Pakistan has five main land regions: (1) the Northern and Western Highlands, (2) the Punjab Plain, (3) the Sind Plain, (4) the Baluchistan Plateau, and (5) the Thar Desert. The total area of the country is 796,095 square kilometres.

**The Northern and Western Highlands.** Mountains cover much of northern and western Pakistan. K2, the second highest peak in the world, towers 8,611 metres above sea level in the part of Kashmir controlled by Pakistan. Only Mount Everest is higher. Mountain passes cut through the rugged peaks at several points. The most famous of these mountain passes, the Khyber Pass, links the northern frontier of Pakistan with Afghanistan (see **Khyber Pass**).

**The Punjab and Sind plains** occupy most of the eastern part of the country. These regions are *alluvial plains* (land formed of soil deposited by rivers). In the north, the Punjab is watered by the Indus River and four of its tributaries—the Chenab, Jhelum, Ravi, and Sutlej rivers. The combined waters of these four tributaries join the Indus River in east-central Pakistan. South of this meeting point, the broadened Indus flows to the Arabian Sea through the Sind Plain. Extensive irrigation systems have made the Punjab and Sind plains fertile agricultural regions.

**The Baluchistan Plateau** is located in southwestern Pakistan. Most of the plateau is dry and rocky and has little plant life.

**The Thar Desert** is located in southeastern Pakistan and extends into northwestern India. Much of the desert is a sandy wasteland. However, irrigation projects have made parts of the desert near the Indus River suitable for farming. See **Thar Desert.**

**Irrigation systems in the Punjab and Sind plains** have made these regions fertile for agriculture.

**Pakistan terrain map**

This map shows the five land regions of Pakistan. The Northern and Western Highlands, which include several towering peaks, are broken by the Khyber Pass and other mountain passes. The Indus River flows through the Punjab and Sind plains, which separate the Baluchistan Plateau from the Thar Desert.

- Land region boundary
- International boundary
- National capital
- Other city or town
- Mountain pass
- Elevation above sea level
- Desert
- Glacier
- Intermittent lake
- Swamp

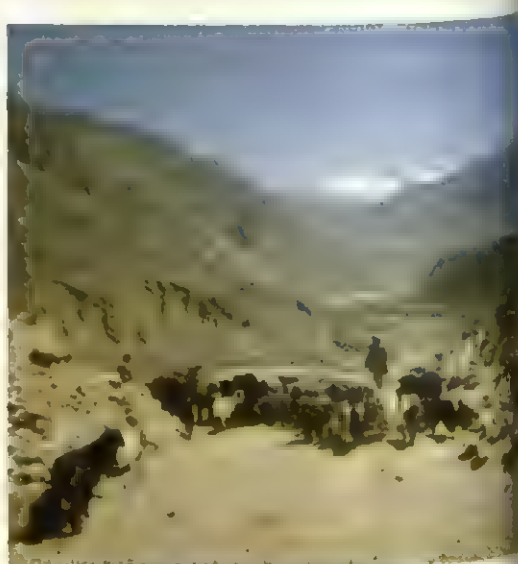
0 100 200 300 Miles
0 100 200 300 400 Kilometres


## Climate

Most of Pakistan has a dry climate, with hot summers and cool winters. Pakistan averages only about 25 centimetres of rain a year. But the amount of rainfall varies greatly from year to year. Long dry spells may be broken by severe rainstorms that cause rivers to overflow and flood the countryside.

In general, most of the rain falls from July to September, when the summer *monsoon* (seasonal wind) blows across Pakistan. The eastern part of the Punjab receives the most rain—more than 50 centimetres a year. Southwestern Pakistan is the driest area. Much of the Baluchistan Plateau receives less than 13 centimetres of rain a year.

Average temperatures vary from one part of Pakistan to another. The mountain regions have the coolest weather. Summer temperatures in the north and northwest average about 24° C and winter temperatures often fall below freezing. In the Punjab, in eastern Pakistan, temperatures average over 32° C in summer and about 13° C in winter. Summer temperatures in the Baluchistan Plateau, in western Pakistan, average about 27° C. Winter temperatures average less than 4° C. The southern coastal region has mild, humid weather most of the year. Temperatures range from about 19° C in winter to about 30° C in summer.



**Cool, sunny weather** is common in the mountainous regions of northern and western Pakistan. Most of Pakistan is dry, with an annual average rainfall of about 25 centimetres.

Pakistan's economy is based chiefly on agriculture. Most Pakistanis make a living by farming the land or by raising goats or sheep. Pakistan had few factories when it gained independence in 1947. Since then, it has worked to develop its manufacturing industries.

The government manages most of the nation's major heavy industries, such as oil refining and iron and steel production. The government has drawn up five-year plans that set production goals for agriculture and industry and establish programmes for economic development. Many of Pakistan's development programmes have been financed by aid from other countries and from international organizations.

**Natural resources.** Pakistan's rivers are its most important natural resource. They supply the water that irrigates over 15 million hectares of farmland. They also provide hydroelectric power.

Large natural gas fields lie in central Pakistan. The country also has deposits of petroleum, coal, iron ore, salt, gypsum, limestone, and chromite.

**Agriculture** employs about half of Pakistan's workers. Many of the farmers own only a small area of land, which they work with simple tools and teams of oxen or buffalo. Since the 1950's, the government has worked to modernize agriculture by encouraging farmers to use fertilizer, pesticides, and new types of seeds. It also has sponsored programmes to limit the size of farms and distribute the land among the poor.

Wheat is the chief crop of Pakistan. The farmers also grow cotton, rice, sugar cane, chickpeas, oilseeds, and fruits and vegetables. Cattle and water buffaloes are raised mainly for use as work animals, but they also provide meat, milk, and hides. Many Pakistanis, especially in Baluchistan and the North-West Frontier Province, tend flocks of goats or sheep. Poultry farms are common in most parts of the country.

**Service industries** employ about a third of Pakistan's workers. Service industries are especially important in the largest cities. Wholesale and retail trades are the largest employers among service industries. Other service industries include education, finance, government, health care, and transportation.

**Manufacturing.** About a seventh of the workers of Pakistan are employed in manufacturing industries. Cotton textiles and clothing rank as the nation's leading manufactured products. Other important manufactures include food products, especially flour and sugar; fertilizer and other chemical products; steel; and cement. Many craftworkers work in their homes or in small factories. They make carpets, embroidered goods, pottery, woodware, and other handicraft items.

**Fishing** is an important industry in the coastal regions of Pakistan. Shrimp, sardines, sharks, and other fish are caught in the Arabian Sea. Pakistan exports a considerable amount of fish and shellfish.

**Foreign trade.** Pakistan trades chiefly with Japan, the United States, Germany, Great Britain, and Saudi Arabia. Its imports include petroleum products, machinery, transportation equipment, iron and steel, food products, electrical equipment, and chemicals. Pakistan exports such products as textiles, clothing, cotton, rice, leather goods, and carpets.

**Transportation and communication.** Railways carry more passengers and freight than do other means of transportation in Pakistan. Roads link the principal cities of the country. But Pakistan has an average of only about 1 car for every 300 people. In rural areas, villagers use camels, cattle, donkeys, or horses for transportation. Karachi is Pakistan's main seaport. International airports operate at Karachi, Lahore, and the Islamabad-Rawalpindi area.

Government-owned companies provide telephone and telegraph services. The government owns Pakistan's radio and television stations. Pakistan has an average of about 1 television set for every 50 people. About 110 daily newspapers are published in Pakistan.

**Modern farm equipment** simplifies the harvesting of wheat, Pakistan's chief crop. Government programmes have helped modernize agriculture in Pakistan. But most of the nation's farmers still use simple tools to cultivate their small plots of land.

**The Indus Valley civilization.** About 2500 B.C., one of the world's first great civilizations began to develop in the Indus Valley in what is now Pakistan. Ruins of Harappa and Mohenjo-Daro (also spelled Moen jo Daro), the two major cities of the civilization, show that both were large and well planned. By about 1700 B.C., the Indus Valley civilization had disappeared. Scholars do not know why it collapsed. See **Indus Valley civilization.**

**Invasions and conquests.** During the next several thousand years, many peoples from southwest and central Asia came into the region that is now Pakistan. About 1500 B.C., a central Asian people called *Aryans* came through the mountain passes to the Punjab region. In time, they settled across almost all of India.

The Persians conquered the Punjab during the 500's B.C. and made it part of the huge Achaemenid Empire (see **Persia, Ancient** [The Achaemenid Empire]). In 326 B.C., Alexander the Great took control of most of what is now Pakistan. A few years later, the emperor Chandragupta Maurya made the region part of the Maurya Empire (See **Maurya Empire**).

The Maurya Empire began to break up about 230 B.C. Greeks from the independent state of Bactria in central Asia then invaded the Indus Valley. They established a kingdom with capitals near the present-day cities of Peshawar and Rawalpindi. About 100 B.C., Scythians from Afghanistan came into Baluchistan and Sind. In time, they conquered the Indus region. The Afghans were replaced by the Parthians, who, in turn, were conquered by the Kushans of central Asia.

The Kushans ruled what is now Afghanistan, Pakistan, and northwestern India from about A.D. 50 to the mid-200's. They controlled the trade routes from China to India and the Middle East. Peshawar, the Kushan capital, became a major commercial centre (see **Kushan Empire**).

During the mid-300's, the Indus Valley became part of the Gupta Empire, which had expanded westward from northeastern India. Huns from central Asia conquered the empire in the mid-400's.

**The coming of Islam.** In A.D. 711, Arab Muslims sailed across the Arabian Sea and invaded Sind, bringing Islam to the region. Beginning about A.D. 1000, Turkish Muslims invaded northern Pakistan from Iran. The Turkish ruler Mahmud of Ghazni established a Muslim kingdom that in time included the entire Indus Valley. Lahore became the capital of the kingdom and developed into a major centre of Muslim culture.

In 1206, most of what is now Pakistan became part of the Delhi Sultanate, a Muslim empire that included northern India. The Delhi Sultanate lasted until 1526, when Babar, a Muslim ruler from Afghanistan, invaded India and established the Mughal Empire.

**The Mughal Empire** included almost all of what is now Pakistan, India, and Bangladesh. Under Mughal rule, a culture developed that combined Middle Eastern and Indian elements. It included a new language, Urdu, which was influenced by both Hindi and Persian. It also included a new religion, Sikhism, which drew beliefs from both Hinduism and Islam. The Mughal Empire began to decline in the 1700's. Several groups, including Persians and Afghans, then controlled the region that is now Pakistan. Sikh kingdoms gained strength in the Punjab during the early 1800's. See **Mughal Empire.**

**The rise of British influence.** Beginning in the 1500's, European traders competed for control of the profitable trade between Europe and the East Indies. A number of trade companies established settlements in India with the cooperation of the Mughal emperors. By the 1700's, the British East India Company had become the strongest trade power in India.

In the 1740's, after the Mughal Empire began to break up, the East India Company gained political control over much of India. The company fought a series of wars in the Punjab and Sind during the 1840's and added these territories to its holdings.

The British government took over control of the East India Company in 1858. All the company's territory then became known as *British India.* By 1900, as a result of wars and treaties with local rulers, British India included all of what is now Pakistan.

**British control.** Britain introduced a number of reforms in India, including the establishment of a Western system of education. Many Hindus enrolled in the British schools, but most Muslims continued to attend their own schools, which stressed religious instruction. By the late 1800's, Western-educated Hindus far outnumbered Muslims in India. Although the Muslims had previously been outnumbered by the Hindus, who made up about three-fourths of the population, the Muslims' lack of Western education reduced their power even further. Large numbers of Hindus gained positions in business and government, but the great majority of Muslims remained farmers and labourers.

In 1875, Syed Ahmad Khan, a Muslim leader, founded the Muhammadan Anglo-Oriental College in Aligarh (now the Aligarh Muslim University in Aligarh, India). This school combined Muslim and Western methods of education. Many of its graduates became leaders of India's Muslim community.

Muslim leaders were divided in their attitude to the Hindus. Some believed Muslims should cooperate with the Indian National Congress, a political organization led by Hindus. But many Muslims thought that if the congress gained power, it would never treat Muslims fairly. In 1906, the Muslims formed a separate political organization called the Muslim League.

**Independence movements** in India began to gain strength during the early 1900's. The Indian National Congress and the Muslim League both sought greater self-government for India. But at the same time, differences between the Hindus and Muslims increased. Almost all the Muslims believed the Hindus would have too much power over them if India gained independence from Britain. In the early 1930's, the Muslim League called for the creation of a separate Muslim nation. Such a nation would have been formed from the parts of India that had a Muslim majority. The president of the Muslim League, Muhammad Ali Jinnah, became a leading supporter of this proposal. The name *Pakistan,* which means *land of the pure* in Urdu, came to be used for the proposed nation.

In 1940, the Muslim League demanded *partition* (division) of India along religious lines. British and Indian

National Congress leaders rejected the idea, but the league refused any other settlement. Riots occurred between Hindus and Muslims during the mid-1940's. In 1947, Britain and the Indian National Congress leaders finally agreed to the partition.

**The new nation.** On Aug. 14, 1947, Pakistan became an independent dominion in the Commonwealth of Nations. India gained independence the next day. Pakistan was created from the northwestern and northeastern parts of India, where Muslims made up the majority of the population. More than 1,600 kilometres of Indian territory lay between the two sections, which were called West Pakistan and East Pakistan. Muhammad Ali Jinnah, considered the founder of Pakistan, became the first head of government.

Fighting between Hindus and Muslims continued even after the partition of India. Thousands died while migrating between India and Pakistan. About 10 million people fled from one country to the other. Hindus and Sikhs fled to India while Muslims fled to Pakistan.

In 1948, India and Pakistan went to war over independent Kashmir. Pakistan claimed Kashmir because most of the people there were Muslims. After Pakistani troops invaded Kashmir, the region's Hindu ruler made it part of India. Indian and Pakistani troops fought until 1949, when the United Nations arranged a cease-fire. See Kashmir.

**The republic.** Pakistan became a republic in 1956, and Major General Iskander Mirza became the first president. Military leaders controlled the government throughout the late 1950's and 1960's.

In 1956, Pakistan began its first five-year plan for economic development. Most of the development projects took place in West Pakistan. In 1967, completion of the Mangla Dam on the Jhelum River provided West Pakistan with flood control, irrigation, and electric power. Construction of one of the world's largest dams, the Tarbela Dam on the Indus River, began in 1969. The dam was completed in 1975.

The dispute over Kashmir led to renewed fighting between India and Pakistan in 1965. Once again, the United Nations arranged a cease-fire.

**Civil war.** The people of East and West Pakistan had been divided both geographically and culturally ever since the nation's creation in 1947. They shared only one major characteristic—their religion. Most East Pakistanis had different physical traits, cultural backgrounds, and traditions from West Pakistanis. Many East Pakistanis objected to West Pakistani control over the nation's government, economy, and armed forces.

In 1970, a cyclone and tidal wave struck East Pakistan and killed about 266,000 people. Many East Pakistanis accused the government of delaying shipments of food and relief supplies to the disaster area.

In 1971, the many differences and disagreements between East and West Pakistan erupted into civil war. In 1970, Pakistanis had elected a National Assembly that was to draft a new constitution. East Pakistan had about 56 per cent of the nation's population, and so a majority of the assembly members were East Pakistanis. The people of East Pakistan wanted a constitution that would give them some self-government.

In March 1971, President Yahya Khan postponed the first meeting of the National Assembly. East Pakistanis staged demonstrations in protest against his action, and Yahya Khan ordered the Pakistani Army into East Pakistan. The East Pakistanis resisted, and civil war broke out. On March 26, 1971, East Pakistan declared itself an independent nation called Bangladesh.

In December 1971, India joined Bangladesh against West Pakistan. The war then developed into a conflict between India and Pakistan, and the fighting spread into parts of West Pakistan and Kashmir. On Dec. 16, 1971, two weeks after India entered the war, Pakistan surrendered. More than a million people had died in the bloody fighting. A few days later, Yahya Khan resigned. Zulfikar Ali Bhutto, head of the Pakistan People's Party, succeeded him. See also **Bangladesh.**

**Millions of Muslims** fled India in 1947 to settle in the newly created nation of Pakistan. Pakistan was carved out of regions of India that had a Muslim majority.

**Recent developments.** As a result of the war, Pakistan lost about a seventh of its area and more than half its population. Its economy was badly disrupted. In 1972, Pakistan withdrew from the Commonwealth of Nations after the United Kingdom established diplomatic ties with Bangladesh. It rejoined in 1989.

Bhutto restored constitutional government and civilian rule to Pakistan. He announced programmes for economic and educational reforms. In July 1972, Bhutto met Prime Minister Indira Gandhi of India. Gandhi agreed to withdraw Indian troops from all Pakistani territory. But Kashmir remained a disputed territory, and India refused to withdraw its troops from Kashmir.

In 1973, Pakistan adopted a new Constitution providing for a president and a prime minister. Bhutto became the country's prime minister. Chaudhri Fazal Elahi was elected president. In March 1977, parliamentary elections resulted in a victory for Bhutto's political party.

In July, military officers led by General Mohammad Zia ul Haq removed Bhutto from office, suspended the Constitution, and declared martial law. Elahi retained the title of president, but Zia ruled as chief martial law administrator. In 1978, Elahi resigned and Zia declared himself president. Zia's military government convicted Bhutto of ordering the murder of a political opponent and he was executed in 1979.

In 1985, President Zia allowed the election of a new parliament, restored much of the Constitution, and ended martial law. In 1988, he removed the prime minister, his Cabinet, and the parliament from power. In August 1988, Zia was killed in an aeroplane crash.

In November 1988, parliamentary elections were held. Benazir Bhutto, head of the Pakistan People's Party (PPP) and daughter of Zulfikar Ali Bhutto, became prime minister. She was the first woman ever to head an elected government in an Islamic nation. In December, the parliament and the four provincial assemblies elected Ghulam Ishaq Khan as president. In August 1990, President Ishaq Khan accused Prime Minister Bhutto's government of corruption. He removed Bhutto from office. A temporary government, with Ghulam Mustafa Jatoi as prime minister, was formed. In elections held in October 1990, the Islamic Democratic Alliance, a coalition of political parties, won the majority of seats in parliament. Nawaz Sharif of the Pakistan Moslem League—the chief party of the coalition—became prime minister.

In July 1993, President Ishaq Khan and Prime Minister Nawaz Sharif resigned. Wasim Sajjad became acting president. In elections held in October, the PPP won a majority of seats in the national assembly. The assembly elected Benazir Bhutto as prime minister. In November, Farooq Leghari was elected president.

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**Questions**

What are Pakistan's principal manufactured products?
Who was Mahmud of Ghazni? Muhammad Ali Jinnah? Syed Ahmad Khan?
What was the main reason for the creation of Pakistan as an independent nation?
Why is Kashmir disputed between India and Pakistan?
How has Pakistan's government tried to modernize agriculture?
What are the chief cultural groups of Pakistan?
Why did Muslims want a separate nation when India gained independence?
In what region do most Pakistanis live?

**Palaeocene Epoch.** See **Earth** (table: Outline of the earth's history).

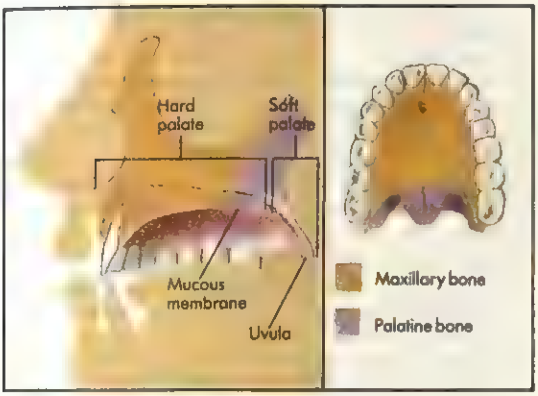
**Palaeogeography.** See **Palaeontology.**

**Palaeography** is the study of ancient and medieval handwriting. It deals mainly with writing on perishable materials, such as papyrus, parchment, or paper. *Epigraphy* is the related study of writing cut into more permanent material, such as metal or stone. Specialists called *palaeographers* study and translate ancient and medieval writings. They examine the shape of the letters and abbreviations used, classify and trace the historical development of the various writing styles, and identify where and when the manuscripts were written.

Medieval styles of handwriting included *book hands,* also called *formal hands; documentary hands,* also called *diplomatic* or *informal hands;* and *national hands.* Book hands were made up of capital and small letters. Documentary hands consisted of flowing writing with the letters joined together. National hands differed according to geographical area. A style called *Gothic script* or *black letter,* which had heavy lines, became widely used in Europe between the 1100's and the 1500's. *Humanistic script* gained popularity throughout Europe in the 1500's and 1600's.

Palaeographers study writing that dates up to the 1600's. By that time, printed works had replaced most handwritten manuscripts. Jean Mabillon, a French monk wrote what was probably the first book on palaeography, *De re diplomatica,* in 1681.

**Palaeolithic Period.** See **Prehistoric people** (The first human beings); **Stone Age.**




**The palate,** or roof of the mouth, separates the mouth and nasal cavities. It has two parts, *left:* (1) the bony *hard palate* in front, and (2) the muscular *soft palate* in the rear. Both parts are covered by a mucous membrane. The hard palate is formed by parts of the maxillary and palatine bones, *right.*

**Palaeontology** is the scientific study of animals, plants, and other organisms that lived in prehistoric times—that is, more than 5,500 years ago. Fossil remains of organisms occur in *sedimentary rocks* (rocks formed when mineral matter settled out of air, ice, or water). The organisms that are now fossils were alive when the rocks were being formed. They were buried and preserved as the layers of rock piled up.

By studying fossils, palaeontologists learn what kind of life existed in various periods of the earth's history. The oldest known fossils are bacteria that lived about $3\frac{1}{2}$ billion years ago. The fossil record shows a gradual increase in the complexity of animals and plants. This gradual change in body form is called *evolution.*

Palaeontology is important in the study of geology. The age of rocks may be determined by the fossils in them. Fossils also tell whether rocks were formed under the sea or on land. Most rocks that contain marine shell fossils were formed under the sea. Most rocks that contain land animal and land plant fossils were formed on land. The knowledge of where rocks were formed helps scientists map the world as it was millions of years ago. Such scientists are called *palaeogeographers.*

Palaeontology aids in the location of oil. Oil is often found in rocks that contain certain fossils. Oil companies use such fossils as a clue to where to find oil.

There are three main branches of palaeontology: (1) invertebrate palaeontology, (2) vertebrate palaeontology, and (3) palaeobotany. Invertebrate palaeontology deals with fossil *invertebrates* (animals without backbones), such as molluscs and corals. Vertebrate palaeontology is concerned with extinct fish, amphibians, reptiles, birds, and mammals. Palaeobotany is the study of fossil plants.

See also **Fossil.**

**Palaeozoic Era.** See **Earth** (The Palaeozoic Era).

**Palanquin,** a device like a litter, was used for many years by Chinese and Japanese, much as Westerners use taxis. The passenger sat or lay on the box-shaped palanquin, which was about 2.5 metres long, 1 metre wide, and 1 metre high. In the side was a door. The structure hung from two poles carried by four people.

**Palate** is the roof of the mouth. The palate has two parts, the *hard palate,* in front, and the *soft palate,* behind. The hard palate is composed of the *palatine* bones and parts of the *maxillary* bones. It is covered with a *mucous membrane.*

The soft palate is a fold of muscular tissue covered by epithelial tissue with mucous glands. The palate separates the mouth and the nasal cavity. During swallowing, the soft palate rises and blocks off the entrance to the rear nasal passage. A projection called the *uvula* hangs from the middle of the soft palate.

Only other mammals and crocodiles have a palate like that of a human being. In other animals, the base of the skull also serves as the roof of the mouth. Fish, amphibians, and reptiles may have teeth growing on the palate. In amphibians, the palate is used to aid breathing.

See also **Cleft palate; Mouth.**

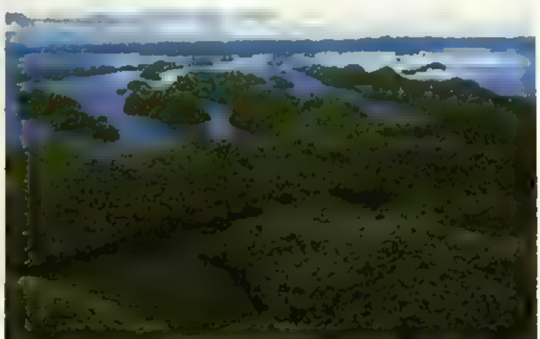
**Palatinate** was the name of two small countries of the old German Empire. One was called the Upper Palatinate. The other was called the Lower, or Rhenish, Palatinate. The Upper Palatinate is now part of Bavaria, joined with Regensburg to make a single province. The Lower Palatinate is part of Rhineland Palatinate. The Lower Palatinate region has long been famous for its fertile soil and its wine. It produces good crops of potatoes, tobacco, hemp, flax, wheat, rye, and barley.

See also **Bavaria.**

**Palau Islands** (pop. 13,000) is the name of a group of islands in the western Pacific Ocean. The Palau, also spelled *Belau,* Islands are a part of the Caroline group in the area known as Micronesia. The islands are located about 800 kilometres east of the island of Mindanao in the Philippines. The Palau group consists of a chain of islands surrounded by a coral reef. The islands extend about 160 kilometres from north to south, and about 30 kilometres from east to west. The Palau group covers 500 square kilometres of land.

The northern islands are of volcanic origin. They are fertile and have many trees. Many tropical fruit and vegetables are grown. The southern islands of the Palau group are formed of upraised coral reef. Some of them are too rugged for people to live on.

The Palau Islands were probably one of the first island groups in Micronesia to be settled. Ancestors of the islanders probably arrived from Asia thousands of years ago. About two-thirds of the people of the Palau



**Palau Islands** are a group of islands in the western Pacific Ocean. In the northern part of the chain, thickly forested islands dot the clear ocean water.

**Palau**


Islands live in Koror, the capital. Most of these people work for government agencies. Most of the rest of the islands' people live in rural villages. They farm the land, but grow only enough food for their own needs.

The Palau Islands belonged to Germany before World War I (1914-1918). The Allies turned them over to Japan after the war ended. Under Japanese control, the islands became the headquarters for all Micronesia. The Japanese built roads and concrete piers, developed modern harbours, and brought in Japanese settlers. The Palaus were closed to foreigners in 1935.

In 1944, during World War II, United States forces drove Japanese military forces from the southern Palaus. After the war ended in 1945, the Japanese settlers in the Palau Islands were sent back to Japan. In 1947, the U.S. government began administering the Palau Islands under a United Nations trusteeship called the Trust Territory of the Pacific Islands. On Oct. 1, 1994, Palau became an independent nation after the people voted for a compact of free association with the United States. Under this system, Palau is self-governing, with the U.S. retaining responsibility for defending the islands. The new Republic of Palau joined the United Nations on Dec. 15, 1994.

See also **Pacific Islands; Peleliu.**

**Palermo** (pop. 699,691) is the capital and chief seaport of Sicily, an Italian island. It lies along the Tyrrhenian Sea in northwestern Sicily. For location, see **Italy** (political map).

Palermo is a centre of industry and trade. Produce from nearby farms is sold or processed in the city. Palermo exports agricultural products, including canned foods, citrus fruit, and wines. Industries include fishing and the manufacture of furniture, glass, steel, and textiles. Visitors travel to Palermo to see its museum, churches, and palaces. The city is also the home of the University of Palermo.

The Phoenicians founded Palermo between the 600's and 500's B.C. After Muslims captured the city in A.D. 831, Palermo became a centre of trade and culture. The Normans conquered the city in 1072 and made it the capital of the kingdom of Sicily. Several countries held Palermo before it became part of Italy in 1860.

**Palestine,** a small, historic land at the eastern end of the Mediterranean Sea, is one of the world's most historic places. Both Judaism and Christianity originated in Palestine. It is the Holy Land, the site of many events described in the Bible. Muslims, the followers of the Islamic religion, also consider Palestine a sacred place.

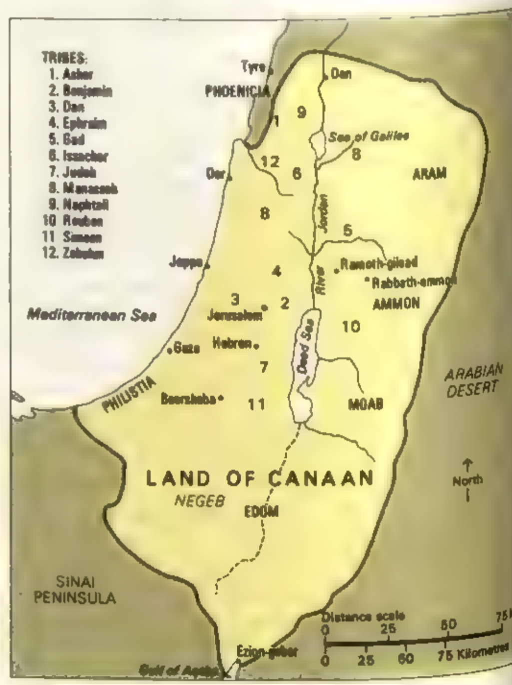
Palestine's location between Egypt and southwest Asia has made it a centre of conflict for thousands of years. Many peoples have invaded the region. In the 400 years before World War I (1914-1918), Palestine was part of the Ottoman Empire. After the war, Palestine came under the control of Britain (also called the United Kingdom). Both the Arab and Jewish inhabitants of Palestine fought for control of the territory. In 1948, as a result of a war between Arabs and Jews, Palestine was divided among Israel, Jordan, and Egypt. Many of its Arab residents became refugees.

**Early history and Hebrew settlement.** Amorites, Canaanites, and other Semitic peoples entered the area about 2000 B.C. The area became known as the Land of Canaan. See **Canaanites.**

Sometime between about 1800 and 1500 B.C., a Semitic people called Hebrews or Israelites left Mesopotamia and settled in Canaan. Some Hebrews later went to Egypt. During the 1200's B.C., Moses led the Hebrews out of Egypt, and they returned to Canaan.

**The Land of Canaan about 1000 B.C.**

Most of the Land of Canaan, later called Palestine, was held by the Twelve Tribes of Israel. The names of these tribes are listed below, and their areas are shown by a number on the map.



For about 200 years, the Hebrews fought the other peoples of Canaan and the neighbouring areas. One of their strongest enemies, the Philistines, controlled the southwestern coast of Canaan—called Philistia.

Until about 1029 B.C., the Hebrews were loosely organized into 12 tribes. The constant warfare with neighbouring peoples led the Hebrews to choose a king, Saul, as their leader. Saul's successor, David, unified the nation to form the Kingdom of Israel, about 1000 B.C. David established his capital in Jerusalem. His son, Solomon, succeeded him as king and built the first Temple for the worship of God. Israel remained united until Solomon's death in about 922 B.C. The northern tribes of Israel then split away from the tribes in the south. The northern state continued to be called Israel. The southern state, called Judah, kept Jerusalem as its capital. The word *Jew,* which came to be used for all Hebrews, comes from the name *Judah.*

**Invasions and conquests.** During the 700's B.C., the Assyrians, a people who lived in what is now Iraq, extended their rule westward to the Mediterranean Sea. They conquered Israel in 722 or 721 B.C. After about 100 years, the Babylonians began to take over the Assyrian Empire. They conquered Judah in 587 or 586 B.C. and destroyed Solomon's Temple in Jerusalem. They enslaved many Jews and forced them to live in exile in Babylonia. About 50 years later, the Persian king Cyrus conquered Babylonia. Cyrus allowed a group of Jews from Babylonia to rebuild and settle in Jerusalem.

The Persians ruled most of the Middle East, including Palestine, from about 530 to 331 B.C. Alexander the Great then conquered the Persian Empire. After Alexander's death in 323 B.C., his generals divided his empire. One of these generals, Seleucus, founded a *dynasty* (series of rulers) that gained control of much of Palestine about 200 B.C. At first, the new rulers, called Seleucids, allowed the practice of Judaism. But later, one of the kings, Antiochus IV, tried to prohibit it. In 167 B.C., the Jews revolted under the leadership of the Maccabeans and drove the Seleucids out of Palestine. The Jews re-established an independent kingdom which they named Judah.

**Roman rule.** In 63 B.C., Roman troops invaded Judah, and it came under Roman control. The Romans called the area Judea. Jesus Christ was born in Bethlehem in the early years of Roman rule. Roman rulers put down Jewish revolts in A.D. 66 and A.D. 132. In A.D. 135, the Romans drove the Jews out of Jerusalem. The Romans named the area Palaestina, after Philistia, at about this time. The name *Palaestina* later became *Palestine* in English.

Most of the Jews fled from Palestine. But Jewish communities continued to exist in Galilee, the northernmost part of Palestine. Palestine was governed by the Roman Empire until the A.D. 300's and then by the Byzantine Empire. In time, Christianity spread to most of Palestine.

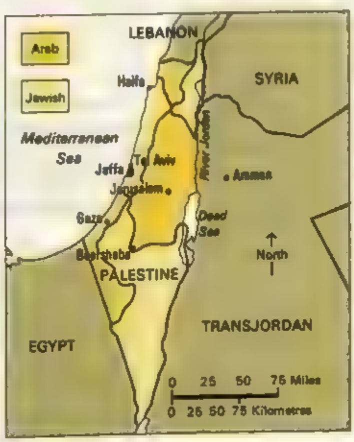
**Arab control.** During the A.D. 600's, Muslim Arab armies moved north from Arabia to conquer most of the Middle East, including Palestine. Muslim powers controlled the region until the early 1900's. The rulers allowed Christians and Jews to keep their religions. However, most of the local population gradually accepted Islam and the Arab-Islamic culture of their rulers.

In the 1000's, the Seljuks, a Turkish people, began to take over Palestine. They gained control of Jerusalem in 1071. Seljuk rule of Palestine lasted less than 30 years. Christian crusaders from Europe wanted to regain the land where their religion had been born. The Crusades began in 1096, and the Christians captured Jerusalem in 1099. They held the city until 1187, when the Muslim ruler Saladin attacked Palestine and took control of Jerusalem. See **Crusades.**

In the mid-1200's, Mameluke rulers based in Egypt established an empire that in time included Palestine. The Ottoman Empire defeated them in 1517. Palestine then became part of the Ottoman Empire. Arab Muslims

**Palestine** The maps below show important stages in Palestine since World War I (1914-1918). In 1920, Palestine—previously part of the Ottoman Empire—became a mandated territory of the UK. The establishment of Israel in 1948 increased the conflicts between Arabs and Jews in the area.


**The British mandate of Palestine** is shown above as it existed in 1922. From 1920 to 1922, the mandate also included the Transjordan mandate to the east.




**The United Nations partition plan** of 1947 divided Palestine into Arab and Jewish areas. The Jewish area became the independent nation of Israel in 1948.


**Palestine today** consists of the nation of Israel and the Arab areas of the Gaza Strip and the West Bank. Israeli troops occupy most of the West Bank.

made up most of Palestine's population. Beginning in the 1500's, Jews from various Mediterranean lands emigrated and settled in Jerusalem and other parts of Palestine. By 1880, there were about 24,000 Jews in Palestine.

**The Zionist movement.** Beginning in the late 1800's, oppression of Jews in Eastern Europe set off a mass emigration of Jewish refugees. Some Jews formed a movement called *Zionism,* which sought to make Palestine an independent Jewish nation. The Zionists established farm colonies in Palestine. At the same time, Palestine's Arab population grew rapidly. By 1914, the total population of Palestine stood at 700,000, of which about 615,000 were Arabs, and 85,000 were Jews. See **Zionism.**

**World War I and the Balfour Declaration.** During World War I (1914-1918), the Ottoman Empire joined Germany and Austria-Hungary against the Allies. An Ottoman military government ruled Palestine. Britain and some of its European Allies planned to divide the Ottoman Empire among themselves after the war. The Sykes-Picot Agreement of 1916 called for part of Palestine to be placed under a joint Allied government. Britain offered to back Arab demands for postwar independence from the Ottomans in return for Arab support for the Allies. In 1916, some Arabs revolted against the Ottomans in the belief that Britain would help establish Arab independence in the Middle East. The Arabs later claimed that Palestine was included in the area promised to them, but the British denied this.

In 1917, in an attempt to gain Jewish support for its war effort, Britain issued the Balfour Declaration. The declaration stated Britain's support for the creation of a Jewish "national home" in Palestine, without violating "the civil and religious rights of the existing non-Jewish communities".

After the war, the League of Nations divided much of the Ottoman Empire into *mandated territories* (see **Mandated territory**). In 1920, Britain received a provisional mandate over Palestine, which would extend west and east of the River Jordan. The British were to help the Jews build a national home and promote the creation of "self-governing institutions". In 1922, the League declared that the boundary of Palestine would be limited to the area west of the river. The area east of the river, Transjordan (now Jordan), was made a separate British mandate. The mandates went into effect in 1923.

The terms of the Palestine mandate were not clear, and various parties interpreted it differently. Many Zionists believed that Britain did not do enough to promote a Jewish "national home". They especially opposed the restrictions set by the British on Jewish immigration and land purchases. The British hoped to establish self-governing institutions, as required by the mandate. But their proposals for such institutions were unacceptable to the Arabs and so none were created.

The Arabs opposed the idea of a Jewish national home. They feared that the British were handing Palestine over to the Zionists by allowing too many Jews to immigrate to Palestine. During this period, a Palestinian Arab national movement first appeared. Riots and demonstrations were mounted by the Arabs to protest against British policies and Zionist activities.

In the early 1930's, over 100,000 Jewish refugees came to Palestine from Nazi Germany and Poland. This development alarmed the Palestinian Arabs. The Arabs organized a general uprising that almost paralysed Palestine during the late 1930's. In 1939, the British began to drastically limit Jewish immigration and land purchases for the next five years. Any Jewish immigration after that would depend on Arab approval.

**World War II and the division of Palestine.** During World War II (1939-1945), most Palestinian Arabs and Jews stopped their resistance to British rule. Many joined the Allied forces. After the war, the Zionists used force to stop Britain from limiting Jewish immigration to Palestine. The Zionists wanted the British to allow immigration of Jewish survivors of the *Holocaust,* the mass murder of European Jews by the Nazis

The United Nations Special Commission on Palestine recommended that Palestine be divided into an Arab state and a Jewish state. The commission called for Jerusalem to be put under international control. The UN General Assembly adopted this plan on Nov. 29, 1947. The Jews accepted the UN decision, but the Arabs rejected it. Fighting broke out immediately.

On May 14, 1948, the Jews proclaimed the independent state of Israel, and the British withdrew from Palestine. The next day, neighbouring Arab nations attacked Israel. When the fighting ended in 1949, Israel held territories beyond the boundaries set by the UN plan. The rest of the area assigned to the Arab state was occupied by Egypt and Jordan. About 700,000 Arabs fled or were driven out of Israel and became refugees.

**The continuing conflict and peace efforts.** The UN arranged a series of cease-fires between the Arabs and the Jews in 1948 and 1949. Full-scale wars broke out again in 1956 and 1967. By the time the UN cease-fire ended the 1967 war, Israel had occupied the West Bank and the Gaza Strip. Israel also held Egypt's Sinai Peninsula and Syria's Golan Heights. In 1973, Egypt and Syria launched a war against Israel. Cease-fires ended most of the fighting by June 1974.

The 1967 war brought almost a million Palestinian Arabs under Israeli rule. In time, the Palestine Liberation Organization (PLO) became recognized by all the Arab states as the representative of the Palestinian people. The PLO pledged to liberate Palestine. Israel strongly opposed the PLO because of its terrorist acts.

In 1978, Egypt and Israel signed the Camp David Accords, an agreement designed to settle their disputes. Israel withdrew from the Sinai Peninsula in 1982. The agreement included provisions for a five-year period of self-government for the residents of the West Bank and the Gaza Strip. This period was to be followed by a decision about the future status of these territories. However, no arrangement for such self-government was made.

Beginning in 1987, periods of violence occurred in the West Bank and the Gaza Strip as protest by Arabs swept through the regions. These actions were called the *intifada,* which means *uprising* in Arabic. Israeli troops killed a number of protesters. In September 1993, Israel and the PLO signed an agreement that included the start of a plan for self-government for, and Israel's withdrawal from, the West Bank and the Gaza Strip. In May 1994, Israeli forces withdrew from Jericho in the West Bank and from most of the Gaza Strip.

See also **Israel; Jordan;** and **Bible,** and their *Related articles;* **Palestine Liberation Organization.**

**Palestine Liberation Organization (PLO)** is the political body that represents the Arab people of Palestine. Its chief goal is to establish a state in Palestine for these Arabs. Palestine is a historic region that now consists of the territories of Israel, the West Bank, and the Gaza Strip.

There are more than 4 million Palestinian Arabs. About 700,000 of them became refugees as a result of the Arab-Israeli war of 1948, when the state of Israel was founded. Today, more than $2\frac{1}{2}$ million Palestinian Arabs live outside what was Palestine.

The PLO includes guerrilla groups and associations of doctors, labourers, lawyers, women, students, and teachers. Some Palestinian Arabs are independent members of the PLO. The guerrilla groups, primarily *Al Fatah*, dominate the organization.

**Organization.** The main organs of the PLO are the Executive Committee, the Central Committee, and the Palestine National Council. The Executive Committee, the main PLO decision-making body, consists of representatives of the major guerrilla groups and some independent members. The Central Committee, which includes representatives of all the guerrilla groups, acts as an advisory group to the Executive Committee. The Palestine National Council, which has about 180 members, serves as the assembly of the Palestinians.

**History.** The PLO was founded in 1964. The Arab governments designated it in 1974 as the "sole, legitimate representative of the Palestinian people." Later that year, the United Nations (UN) recognized the PLO as the representative of the Palestinian Arabs. The PLO did not recognize Israel's right to exist.

Since the 1960's, PLO guerrilla groups have staged attacks against Israel from time to time. Israel, in turn, has attacked PLO bases. From 1965 to 1971, the PLO operated from Jordan, where it also challenged the rule of King Hussein of Jordan. But Jordanian army forces drove out the PLO in 1971. The PLO then moved to Lebanon. From there, it continued to mount attacks against Israel. In 1982, Israel invaded Lebanon and drove the PLO out of southern Lebanon and Beirut. After Israeli troops withdrew from most of Lebanon in 1985, some PLO members returned to southern Lebanon.

Yasir Arafat has been chairman of the PLO since 1969. In 1983, the Syrian government supported rebels within the PLO who opposed Arafat's leadership. The rebels drove Arafat and his PLO forces out of northern Lebanon. In the mid-1980's, the PLO was seriously weakened by its internal conflicts, Israeli opposition, and conflicts with important Arab governments. But the Palestinian people and a majority of the Arab governments continued to support Arafat and the PLO.

In 1987, Palestinians in the West Bank and Gaza Strip began a series of violent demonstrations known as the *intifada*. The PLO helped support the Palestinians. Israeli troops assassinated the top PLO official responsible for the support.

Until 1988, Jordan provided the West Bank with financial and administrative support. But in July 1988, King Hussein announced that his country would end its support. He called on the PLO to take over Jordan's role in the West Bank. In late 1988, Arafat announced the PLO's recognition of Israel's right to exist alongside a Palestinian state. He also renounced the use of terrorism. But some PLO members opposed to Arafat continued to launch terrorist attacks against Israeli targets.

In 1991, the Lebanese Army demanded that PLO members in southern Lebanon leave their military bases there. After the Lebanese defeated the PLO in a series of battles, most PLO members left the bases.

Peace talks between Israel, a number of Arab countries, and the Palestinians began in late 1991. Only Palestinians from the occupied territories were allowed to participate. PLO leaders advised the Palestinians during the talks. But separate discussions between the PLO and Israel took place. In September 1993, the PLO and Israel granted each other unqualified recognition and signed an agreement that included steps to end their conflicts. The agreement provided for the start of a plan for self-government for, and Israel's withdrawal from, the Gaza Strip and the West Bank. In May 1994, Israel withdrew from the Gaza Strip and the West Bank city of Jericho. Palestinians began administering these areas.

See also **Arafat, Yasir; Palestine.**

**Palestrina, Giovanni** (1525?-1594), was one of the greatest composers of the Italian Renaissance. For the Roman Catholic Church, Palestrina wrote about 250 unaccompanied choral works called *motets,* and 93 masses. Two famous works are the mass called *Missa Papae Marcelli* (about 1562) and his setting of the *Stabat Mater* (about 1563). He also composed unaccompanied nonreligious choral pieces called *madrigals.* The most famous of these is *Vestiva i colli* (1566).

Palestrina was a master of the *polyphonic* style of music, in which each voice has a separate melody. In his music, the voices imitate each other in graceful melodic curves, maintaining a steady rhythm. For contrast, the choir sometimes sings together in chords.

Palestrina took his name from his birthplace, the town of Palestrina, near Rome. His full name was Giovanni Pierluigi da Palestrina. From 1571 until his death, he was music director of the Julian Chapel at St. Peter's Church in Rome.

**Palindrome** is a word, sentence, or verse that is spelled the same from right to left as from left to right. The word comes from the Greek *palindromos,* meaning *running back again.* The names *Ada, Eve, Hannah,* and *Otto,* and the words *boob, did, gag, noon, peep,* and *radar* are palindromes. One story credits Napoleon I with the palindrome *"Able was I ere I saw Elba."*

**Palladio, Andrea** (1508-1580), was an architect of the Italian Renaissance. The influence of classical Roman architecture appears in his buildings. Palladio's *Four Books on Architecture* (1570) was a significant work of Renaissance architectural theory. Palladian design influenced the work of Inigo Jones in England during the 1600's and the Georgian style of architecture in England during the 1700's. Palladio's influence reappeared in the late 1900's in a movement called *post-modernism.*

Palladio was born Andrea di Pietro della Gondola, in Padua, Italy. In 1524, he became an assistant to two stone carvers in Vicenza, Italy. He then was employed to work on an addition to a villa outside Vicenza. The owner of the villa, the Italian humanist Giangiorgio Trissino, gave him the name of Palladio, referring to Pallas Athena, the Greek goddess of wisdom. Palladio's major buildings are villas, palaces, and churches, most of them in or near Vicenza and Venice. For a picture of his Villa

**A Palladio church** called San Giorgio Maggiore, in Venice, Italy, was designed in 1565 and completed in 1610.

Rotonda (begun about 1567), also known as the Villa Capra, see **Architecture** (Renaissance architecture).

See also **Architecture** (The Palladian revival); **Jones, Inigo; Georgian architecture; Furniture** (The Palladian style).

**Palladium** is a chemical element with symbol Pd. It is a soft, shiny, silvery-white metal. It is one of six platinum metals, and is relatively rare (see **Platinum**). Palladium is often used in place of platinum because it is cheaper, harder, and lighter than platinum. It is found with deposits of other platinum metals, with nickel-copper ores, and with mercury. Palladium can be drawn into wire or hammered into sheets. It is often mixed with gold to make "white gold" jewellery. Palladium is also used in making surgical instruments.

Finely divided palladium, called *palladium black*, is used as a *catalyst*, a substance that causes or speeds up chemical changes. It is an important catalyst in a process called *hydrogenation*, which is used to improve the quality of oils and to prepare petrol. Car manufacturers use palladium, with platinum and rhodium, in *catalytic converters*. These devices reduce the pollutants in the exhaust gases of car engines (see **Catalytic converter**).

The English chemist William Wollaston discovered palladium in 1803. It has the atomic number 46, and the atomic weight 106.42. It melts at 1552° C and boils at 2940° C. It has a density of 11.99 grams per cubic centimetre at 20° C. Palladium forms simple compounds when combined with elements such as hydrogen, oxygen, and chlorine.

**Pallas,** or Pallas Athena. See **Athena.**

**Palm** is a group of trees, vines, and shrubs that typically grow in warm and wet climates, especially in the tropics. Palms are among the most important plants in tropical regions because they provide food, drink, fibres, and building materials for the people. Palms are most diverse and most common in Southeast Asia, the Pacific islands, and in tropical America. They grow wild as far north as Korea, Japan, and the states of North Carolina and California in the United States; and as far south as Argentina, central Chile, New Zealand, and South Africa. They also are cultivated on plantations in many tropical regions. Some palms live more than 100 years.

Palms are an ancient group of plants. Fossils of palm leaves have been found that date from the Age of Reptiles. Palms once grew in all parts of the world, and palm fossils have been found as far north as Greenland.

**Kinds of palms.** There are more than 2,800 kinds of palms, and they vary greatly in size and the kind of flowers, leaves, and fruit they produce. Most palms grow straight and tall. But the trunks of some palms may lie on the ground. Some have most of the trunk buried in the soil. The rattan palms found in the jungles of Southeast Asia have slender, vinelike stems from 3 to 75 metres long. The stems may trail along the jungle floor or climb high in the trees. Most palms have a single trunk or stem. But many have clustered trunks that grow from the same root base.

***The trunk*** is usually straight and round and from 10 to 60 centimetres thick. But some palms have trunks that are no thicker than a pencil, while others have trunks that are 1.5 metres thick. The trunk may range from a few centimetres to well over 30 metres tall. The trunks of the larger palm trees grow from 30 to 120 centimetres a year. The trunk may have rough or smooth bark, and some have thorns. Only a few palms have branches growing from the trunk. A few kinds have a strawlike "skirt" of dead leaves that hangs down along the trunk. Most palms have their fanlike or featherlike leaves clustered at the top of the trunk.

***The leaves*** vary greatly in size and appearance. The smallest leaves are less than 30 centimetres long. Most of the fanlike leaves are from 60 to 120 centimetres wide, and the featherlike types may be 6 metres long and from 30 to 120 centimetres wide. Two types produce the largest leaves. The talipot palm has fan-shaped leaves that may be 4.5 metres wide. The raffia palm's leaves may be 20 metres long and 2.5 metres wide. Mature leaves remain on a palm from one to nine years.

***The fruit*** differ greatly in size and shape. Some fruit are no larger than a pea. The huge fruit of the double coconut palm may grow as large as 60 centimetres in diameter. The fruit of the palm contains from one to seven seeds. The flesh of the fruit may be soft as in the date, or firm and threadlike, as in the coconut. The seed may be

**Coconut palms** grow as high as 30 metres. Their fruit, the coconut, *above left*, is one of the largest of all seeds. Many wash up on beaches and begin to grow, *above right.*



**Canary Island date palms,** *left,* have an especially dense crown. The trunk of the Washingtonia palm, *centre,* is partly covered by a "skirt" of dead leaves. Royal palms, *right,* have a whitish trunk.

hard, as in the date. Only rarely is it soft, or even hollow and filled with "milk," as in the coconut.

**Products of palms.** Palms provide ornament, shade, building materials—both timbers and thatch—and fuel. Fibres for making ropes and brooms and for *caulking* (making watertight) ships are made from the palm. Strips of leaves are woven into mats, hats, and baskets. Oil for food and lighting comes from several species, particularly the oil palm. The sugary sap of such palms as the palmyra palm can be made into food, sweet drinks, and intoxicating beverages such as arrack. The starch of palms is used for food. The seeds are made into buttons and carvings. The seeds of the betel palm are chewed as a stimulant. A few palms have poisonous seeds.

The palm is most important to the people who live in the tropics. But people in other parts of the world also use palm products. The dried oily meat of the coconut is used to flavour cakes. Its rich oil is used in soap, salad oils, cooking fats, and margarine. Oil from the oil palm is used in cosmetics and in pharmaceutical creams and ointments. Dates are a familiar product of the date palm. Sago is a starch taken from palm trunks.

Many baskets and chair bottoms are woven from strips of palm leaves. The stems of the rattan palm are used in making furniture. Raffia is made of thin layers of cells stripped from the leaves of a Madagascar palm. Wax from the leaves of the carnauba palm of Brazil is used in such products as shoe polish.

**Scientific classification.** Palms belong to the palm family, Palmae (Arecaceae).

**Related articles** in *World Book* include:

**Palm products**

| | | |
|---|---|---|
| Carnauba wax | Raffia | Sago |
| Palm oil | Rattan | |

**Types of palm trees**

| | | |
|---|---|---|
| Betel | Date palm | Palmetto |
| Cabbage palm | Doum palm | Palmyra palm |
| Coconut palm | Ivory palm | |

**Palm Island** is a cluster of islands 64 kilometres north of Townsville, and 32 kilometres east of Ingham, in North Queensland, Australia. Great Palm Island, the largest island of the cluster, covers 65 square kilometres. Its steep hills are covered with dense rain forest. At Challenger Bay, in the northwest of the island, there is a government Aboriginal settlement of about 2,000 people.

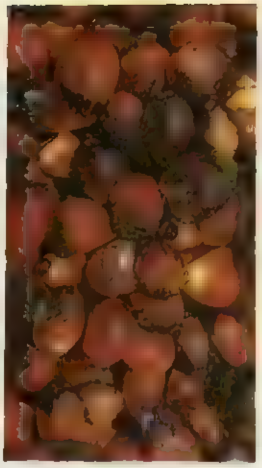
**Palm oil,** made from the fruit of the oil palm tree, is one of the most widely used vegetable oils in the world. Only soybean oil is produced in greater quantities. World production of palm oil totals nearly 13 million metric tons annually. Palm oil is used in products such as ice cream, cooking oil, margarine, and soap.

**Leading palm-oil producing countries**

Amount of palm oil produced in a year

| | |
|---|---|
| Malaysia | 6,373,500 metric tons |
| Indonesia | 3,162,200 metric tons |
| Nigeria | 900,000 metric tons |
| Colombia | 304,500 metric tons |
| Thailand | 270,000 metric tons |
| Ivory Coast | 260,800 metric tons |
| Papua New Guinea | 206,000 metric tons |
| Zaire | 183,000 metric tons |
| Ecuador | 167,000 metric tons |
| China | 140,000 metric tons |

Source: Food and Agriculture Organization (1992).



**Oil palm fruit** is transported to a factory, *above left*, where it is shelled and cleaned, *above right*, before being processed.

The fruit of the oil palm is reddish-orange and about the size of a date. The oil palm tree has 10 to 15 fruit clusters, each consisting of about 200 fruit. The clusters are cut from the trees and taken to a mill, where they are sterilized and separated into the individual fruit. A machine called a *digester* converts the fruit into a mash, which is crushed to obtain crude palm oil. The crude oil is dehydrated, cleaned, and refined.

In the early 1900's, oil palm trees were planted in parts of Africa and on old rubber plantations in Malaysia and Indonesia. Malaysia is now the leading producer, supplying over half the world's palm oil.

**Palm Springs** (pop. 40,181) is a resort city in southern California, U.S.A., that is surrounded by desert and mountains. The city is named after the palm trees that line its streets and after its natural hot springs. These features—plus a warm climate, fashionable hotels and private houses, golf courses, and swimming pools—make Palm Springs a major tourist attraction. About 2 million tourists visit Palm Springs each year.

About a fifth of the city's area is part of a reservation of the Agua Caliente band of Cahuilla Indians. The Indians lived in the area long before it was settled by whites in the late 1800's. In the 1930's, Palm Springs became a popular resort for film stars.

**Palm Sunday** is the Sunday before Easter and marks the beginning of Holy Week in the Christian calendar. Palm Sunday worship recalls when people spread palm leaves and clothing in front of Jesus as He entered Jerusalem. This happened several days before He was crucified. Palm Sunday marks a turn in Christian churches' observance of Lent, from a time of discipline and sorrow for one's sins to one of looking ahead to the *Passion* (suffering and death) of Jesus and His Resurrection.

By the late 300's, Christians in Jerusalem were celebrating Palm Sunday on the first day of Holy Week. It was part of a trend there to remember the last events of Jesus' life by holding services at sacred sites in the city. Today, Christians in many traditions observe the day with the blessing and distribution of palm leaves. Usually, the ceremony includes a procession.

See also **Easter** (picture: Palm Sunday).

**Palmer** is a river in northern Queensland, Australia. It was the site of the first large profitable goldfield found in Queensland. R. Hann, a cattleman, first discovered the gold in 1872. But he continued his work as a drover and left the development of the rich goldfield to James Venture Mulligan. By 1875, more than 20,000 Chinese had walked the great distance through the scrub from Cooktown to the goldfield. To protect their gold from robbers, some Chinese hid it in the urns that contained the ashes of others who had died and been cremated on the goldfield. Many Chinese were able to send these gold-filled urns back to their relatives in China.

**Palmer, Arnold** (1929- ), an American golfer, became one of the greatest and most popular players in the history of the sport. Palmer was the first player to win the Masters tournament four times—in 1958, 1960, 1962, and 1964. Palmer's appealing personality and bold playing style helped to greatly increase the popularity of golf in the late 1950's and early 1960's. Throughout his career, Palmer has attracted a huge crowd of supporters called "Arnie's Army" at tournaments. His charisma also was largely responsible for making golf a popular television sport.

Arnold Daniel Palmer was born in Latrobe, Pennsylvania, U.S.A. Palmer turned professional after winning the U.S. Amateur tournament in 1954. He won the U.S. Open in 1960 and the British Open in 1961 and 1962.

See also **Golf** (picture).

**Palmer, Geoffrey** (1942- ), a Labour politician, served as prime minister of New Zealand from August 1989 to September 1990. He succeeded David Lange.

Geoffrey Winston Russell Palmer was born in Nelson, in the South Island of New Zealand. He was educated in Nelson and studied law at the Victoria University of Wellington, and the University of Chicago. He worked as a solicitor in Wellington before becoming a law professor, first in the United States and then in Wellington. Later, he acted as an adviser on accident compensation to the governments of Australia, Sri Lanka, and Cyprus. Palmer was elected to parliament in 1979. During his career as a minister, he helped change many government departments into state-owned corporations (see **Corporation**). Palmer became deputy leader of the New Zealand Labour Party in 1983.

**Palmer, Samuel** (1805-1881), an English landscape painter and etcher, is best known for his mystical and imaginative pastoral scenes in watercolour. His work was influenced by his short but fruitful friendship with William Blake (see **Blake, William**). Among Palmer's best works are illustrations for John Milton's poems "L'Allegro" and "Il Penseroso."

Palmer was born in London. He exhibited at the Royal Academy and at the Water Colour Society. His late works show a decline in quality.

**Palmer, Vance** (1885-1959), an Australian author, excelled in character sketches and studies of ordinary people in his short stories and novels. His short stories include *Separate Lives* (1931) and *Sea and Spinifex* (1934). His novels include *The Passage* (1930), *Golconda* (1948), and *The Big Fellow* (1959). With the Australian playwright Louis Esson, Palmer did much to develop drama in Australia.

He established character in terms of human environment. His main character studies were of ordinary men.

Human life and the sea intermingle in the study of the Callaway family in Palmer's *The Passage* and in his *Golconda* trilogy.

Palmer was born in Bundaberg, Queensland, Australia.

**Palmerston, Viscount** (1784-1865), an English statesman, served with distinction as a British foreign secretary and prime minister. He became secretary of state for foreign affairs in 1830 and, except for a short interval, held the post until 1841. After a five-year absence, he returned to the Foreign Office in the cabinet of Prime Minister Lord John Russell. He established friendly relations with France, helped Belgium gain independence, and supported Turkey against Russia. Russell, however, dismissed him in 1851. Without consulting his cabinet colleagues or Queen Victoria, Palmerston had approved the seizure of power in France by Napoleon III.

Palmerston's aggressive foreign policy was popular in England, though criticized abroad and in the British Parliament. He had a high conception of Britain's place in the world, and demanded respect for his country from other nations. In one of his speeches, he reminded his listeners that a citizen of ancient Rome was safe anywhere in the Roman Empire, and declared that Britain would also protect its subjects the world over.

Palmerston became prime minister in 1855. He saw the Crimean War to a successful end, but resigned in 1858 over criticism of his policy in China. He again served as prime minister from 1859 until his death.

Palmerston was born at Broadlands, Hampshire, England. His full name was Henry John Temple. He won election to the House of Commons in 1807, and two years later became secretary at war. He held this office for 19 years.

**Palmerston North** (pop. 67,405) is a city in the North Island of New Zealand. It is located in the Wellington region on the inland fringe of the Manawatu Plains. It stands on the banks of the Manawatu River. The city is the centre of a major road, rail, and air transport network that serves the southern half of the North Island. Palmerston North is the marketing and distribution centre for the prosperous dairying and sheep-farming Manawatu region. It is also an industrial centre. Massey University and several agricultural research and development centres are located in Palmerston North.

**Palmetto** is the name given to 14 *species* (kinds) of fan-leaved palm trees. The best-known palmetto is the *cabbage palm.* Among other kinds of palmettos are the *dwarf, blue,* and *saw* palmettos. They grow in low regions along the United States coast, particularly in the southeastern part of the country, and in the West Indies. Some may grow up to 15 metres high, but the dwarf variety is low. The leaves of palmetto palms are used to make baskets, hats, mats, and furniture.

**Scientific classification.** Palmettos belong to the palm family, Palmae (Arecaceae). They make up the genus *Sabal.*

See also **Cabbage palm.**

**Palmistry** is the practice of foretelling the future by examining the lines and marks on the palm of the human hand. Palmistry, sometimes called *chiromancy,* probably began in ancient India. It was once considered a science. Today, most people regard palmistry as a *pseudoscience* (false science). But people in many parts of the world practise palmistry.

In palmistry, the fleshy parts of the palm at the base of the thumb and fingers and on the side of the hand are called *mounts.* The mounts are named after Apollo, the god of the sun in Greek and Roman mythology; the moon; and the planets Venus, Jupiter, Saturn, Mercury, and Mars. A well-developed, fleshy mount supposedly means that a person has the characteristics associated with that mount. For example, the mount of Apollo indicates art and riches. Jupiter signifies ambition and pride, and Venus represents love and music.

The wrinkles on the palm are called *lines.* Like the mounts, each line has a name and a meaning. For example, a long line of life supposedly foretells a long life. A long, clear line of the heart indicates an affectionate disposition. A strongly marked line of the head signifies intelligence and imagination.

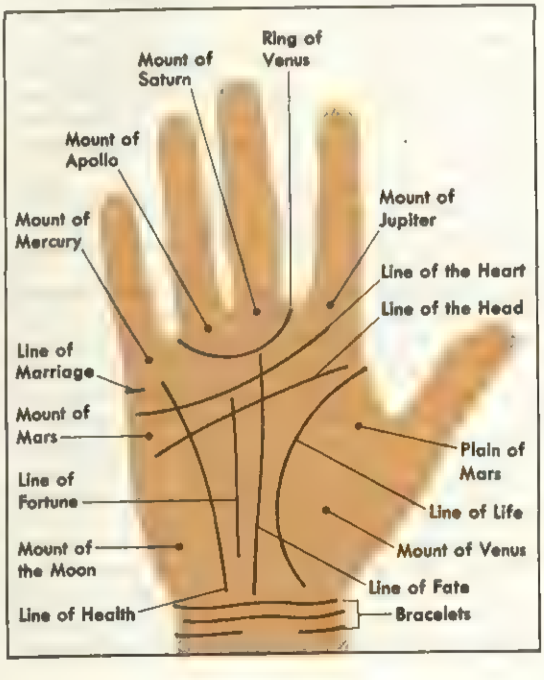
Many palmists also use various physical and psychological clues in making predictions. Nervousness or small muscular reactions to statements made by the palmist may reveal a person's feelings. The condition of the hands and nails also indicates some characteristics. Such signs may help the palmist make surprisingly accurate predictions.

Some palmists use the form of the hand to describe an individual's personality as part of the process of predicting the future. Many of the people who believe in palmistry try to connect it with other occult practices, such as *astrology* (fortunetelling by the stars and planets).

See also **Fortunetelling.**

**Features of the hand in palmistry**

The chart below shows the major features of the hand used in reading palms. Palmists study the wrinkles, called *lines,* and the fleshy pads, called *mounts.* These features, palmists claim, can reveal a person's character and foretell that person's future.



**Palmyra** was an ancient Syrian city, about midway between the eastern coast of the Mediterranean Sea and the Euphrates River. Palmyra was built around a desert *oasis* (fertile place with water) on an important trade route between the Roman and Persian empires. Travelling caravans stopped at Palmyra, bringing great riches and a variety of individuals and cultures. The temple of Palmyra's chief god, Bel, is typical of the mixture of cultures. Although Bel was an eastern god, the temple's architecture is Roman.

By the A.D. 160's, Palmyra had come under Roman control. Camel troops from Palmyra served in the Roman army. Roman garrison troops helped protect Palmyra. But when Persia invaded Syria in about 260, Rome had no troops to spare for Syria's defence. Septimius Odenathus, a Palmyrene prince, commanded the Palmyrene cavalry and archers that turned back the invading Persians. In 262, he became Rome's supreme military commander on the eastern frontier. Odenathus died in 267 and his widow Zenobia succeeded him.

Zenobia, a vigorous and able ruler, tried to extend her rule over Egypt and all Asia Minor. Her troops seized land from the Roman emperors. But the Roman emperor Aurelian defeated and captured Zenobia in 274, and destroyed Palmyra. The emperor Diocletian, who ruled from 284 to 305, rebuilt the city, but Muslims destroyed it again in the 600's.

See also Syria (picture: Ruins of Palmyra).

**Palmyra palm** is a tree that grows throughout India and nearby islands and in other hot countries. It grows from about 6 to 20 metres high. The leaves can grow to over one metre long. The fruit is large and angular. The tree is one of the most useful plants known. Timber from the trunk is used for building houses. The leaves are made into thatch, baskets, mats, hats, fans, and umbrellas. The fibre of the plant is used for twine and rope. The fruit, seeds, and young stalks are eaten. In northern Sri Lanka, the palmyra is almost the sole source of livelihood for thousands of people.

The ancient Hindu scholars used strips from the leaves of the palmyra and talipot palms for writing material. Some of the oldest existing Hindu manuscripts are preserved in books made of these strips. The books are about 30 to 60 centimetres long and never more than 5 centimetres wide.

**Scientific classification.** The Palmyra palm belongs to the palm family, Palmae (Arecaceae). It is *Borassus flabellifer.*

**Palo Alto, Battle of.** See Mexican War (Principal battles).

**Palomar Observatory** is an astronomical observatory in southwestern California, U.S.A. It is best known for its Hale telescope, which is one of the world's largest optical telescopes. This instrument, whose construction was proposed by George E. Hale, an American astronomer, has a main mirror 508 centimetres in diameter. The observatory stands on Palomar Mountain, 1,725 metres above sea level, about 64 kilometres northeast of San Diego. It was completed in 1948 and is operated by the California Institute of Technology. Astronomers at the observatory study the origin and development of stars and their physical and chemical characteristics.

The Hale instrument is a large reflecting telescope. Its concave main mirror can collect a million times as much light as the human eye. It is used to photograph celestial

**Palomar Observatory** is an astronomical observatory in southwestern California, U.S.A. The largest telescope is the 508-centimetre Hale reflector, shown above in its dome.

bodies and their spectra and to measure their brightness. It can photograph objects several billion *light-years* away. A light-year equals about 9.46 trillion kilometres.

The observatory also has two wide-angle photographic telescopes of the type invented by Bernhard Schmidt, a German optician, and a general-purpose reflecting telescope with a main mirror 152 centimetres in diameter. The Schmidt telescopes are used to map the sky and to locate celestial bodies for detailed study with the Hale telescope. The largest of the Schmidt telescopes has a 122-centimetre diameter mirror. It can photograph an area of the sky more than 300 times as large as that seen by the Hale telescope. However, the Hale telescope provides photographs with greater detail. Astronomers have used the 122-centimetre Schmidt telescope to produce a photographic atlas covering all the northern sky and half the southern sky.

**Palomino horse.** See Horse (Colour types; picture: Palomino).

**Paloverde** is a thorny little tree that grows in the dry regions of the southwestern United States and northwestern Mexico. It grows to between 4 and 9 metres tall and its trunk may be over 50 centimetres in diameter. It has green bark and leaves about 2.5 centimetres long that unfold in late March or April. The leaves fall almost as soon as they are fully grown, and the tree is usually bare by late summer. In late spring, the paloverde bears small yellow flowers.

The paloverde produces seed pods about 5 to 8 centimetres long. Each pod contains two or three large seeds. Paloverde seeds were once an important source of food. Indians dried them and ground them into meal or ate them like lima beans. The roots of the paloverde help hold loose desert soil together and slow *erosion* (wearing away) of the soil.

**Scientific classification.** Paloverdes belong to the pea family, Leguminosae (Fabaceae). One common species *Cercidium floridium.*

**Palpitation.** See Tachycardia.

**Palsy** means the same as *paralysis,* the loss of movement or sensation (see **Paralysis**). The term *palsy* is most commonly used in connection with certain types of paralysis. Some kinds of palsy are caused by continued pressure on a nerve. Shaking palsy *(paralysis agitans),* an involuntary tremor of the muscles, is another name for Parkinson's disease. *Chemopallidectomy* is an operation for this uncontrollable tremor.

See also **Bell's palsy; Cerebral palsy; Parkinson's disease.**

**Pamirs** is a huge region, where the Himalaya, Hindu Kush, Kunlun, and Tian Shan mountains meet. It is one of the highest plateaus of the world. This "Pamir Knot" is called *Bam i Dunya,* which means *roof of the world.* The Pamirs lie in central Asia, on the frontiers of Tajikistan, China, India, Pakistan, Afghanistan, and Kyrgyzstan. The Pamirs cover 93,200 square kilometres, at a height of between 4,000 and 4,500 metres above sea level. For location, see **Tajikistan** (map).

Most of the region is treeless, with either grass or bare rock. Rugged mountains are cut by deep canyons. In summer the native people find pasture for their cattle on the gentler slopes of the Pamirs, along the few lakes and the *Amu Darya* (Oxus River). Snow covers the mountains and blocks the passes for more than half of each year. High winds blow across the region's barren mountains during the summer months.

See also **Asia** (Mountains); **Hindu Kush.**

**Pampa** is a Spanish word that means *plain.* Geographers use the word *pampa* for several great plains of South America. But it is most commonly used for the huge plain in Argentina that fans out around Buenos Aires. An area of fertile soil and much grassland, the Argentine Pampa yields abundant crops and supports livestock. It is also the site of most of Argentina's urban areas. More than two-thirds of Argentina's people live on the Pampa. See also **Argentina** (terrain map; The Pampa; Agriculture).

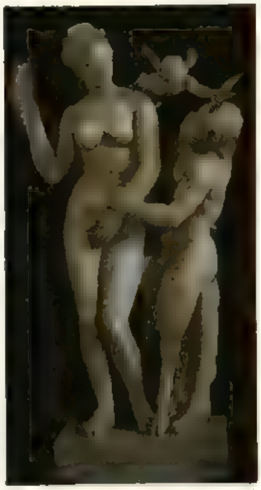
**Pampas grass** is the name of some 20 species of grasses that form large clumps with tall silvery, flowering plumes. Most species come from South America. There are a few species in New Zealand. Pampas grass is grown in many countries as an ornamental plant. It requires well-drained, fertile soil in a sheltered, sunny position. In South America pampas grass is used like *papyrus* to make paper (see **Papyrus**).

**Scientific classification.** Pampas grass belongs to the grass family Gramineae (Poaceae), genus *Cortaderia.*

**Pamphlet** is a short published work of topical interest. It is usually bound between paper covers. Pamphlets originally consisted of manuscripts bound between covers. The word *pamphlet* comes from *Pamphilus, seu de Amore,* a Latin poem published in this form in the 1100's. Most early pamphlets discussed religion. In the 1600's and 1700's, pamphlets also discussed politics.

**Pan** was the god of woods and pastures in Greek mythology. He also was the protector of shepherds and their flocks. Shepherds and farmers prayed to Pan to make their animals fertile.

Pan was half man and half goat. The ancient Greeks believed he had a wild, unpredictable nature. They also thought he had the power to fill human beings and animals with sudden, unreasoning terror. The word *panic* comes from his name.



Marble sculpture (A.D. 1-99); National Museum of Athens

**The Greek god Pan** was half man and half goat. He had many love affairs with divinities. In this sculpture, he is with Aphrodite *left,* and Eros, *centre,* the goddess and god of love.

The Greeks associated Pan with wilderness regions. They believed he lived in caves, on mountain slopes, and in other lonely places. The worship of Pan began in Arcadia, a remote region of southern Greece. Pan's father, Hermes, also was associated with Arcadia. The worship of Pan spread until he became one of the most popular gods. He was often represented in art.

Pan had many love affairs with nymphs and other divinities (see **Nymph**). He tried to start an affair with the nymph Syrinx, but she ran away from him in terror and begged the gods to help her. The gods changed Syrinx into a bed of reeds, from which Pan made a musical instrument called a *panpipe* or *pipes of Pan.* He became famous for the beautiful music he played on the panpipe.

See also **Faun.**

**Pan-Africanist Congress of Azania** (PAC) is a political party that represents the interests of black South Africans. It aims to redistribute South Africa's land and wealth to disadvantaged citizens who suffered under a system of enforced ethnic separation known as *apartheid* (see **Apartheid**). One of the PAC's goals was the formation of a union of all the states of Africa, under the leadership of black Africans.

The PAC was formed in 1959 as a breakaway group from the African National Congress (ANC). Led by Robert Mangaliso Sobukwe (1924-1978), a university lecturer, the PAC's founders objected to the nonracial philosophy of the Freedom Charter, which the ANC had adopted in 1955. In 1960, the PAC and ANC organized demonstrations against the *pass laws,* which regulated the movements of people classified as black under apartheid. In March 1960, one demonstration led to the massacre of 69 demonstrators by police at Sharpeville. Both the PAC and the ANC were then banned by the government.

Sobukwe was imprisoned for six years in 1963. Other PAC leaders escaped into exile and set up an armed wing, Poqo, in African countries outside South Africa. A new military wing, the Azanian People's Liberation Army (APLA), was formed in 1968, taking its name from Azania, an ancient name for Africa.

South African president F. W. de Klerk lifted the ban on the ANC and the PAC in 1990. Under the leadership of Clarence Makwetu, who became PAC president in 1990, the PAC refused to enter negotiations with the South African government. During the early 1990's, both the PAC and APLA earned a reputation as extremist organizations, with APLA claiming responsibility for terrorist attacks on the police and on whites. In South Africa's

first democratic general election, held in April 1994, the PAC received 1.2 per cent of the vote, winning five seats in the National Assembly.

See also **Africa** (Africa today); **African National Congress; South Africa.**

**Pan-American conferences** bring together representatives from countries of North, Central, and South America. These meetings also have been called *Inter-American conferences.* Through them, the nations of the Americas have worked to create friendly relations with one another.

Simón Bolívar, the South American statesman, took the first steps toward setting up an arrangement among American republics (see **Bolívar, Simón**). Through his efforts, the independent American countries held their first conference in 1826 in Panama City, Panama.

The First International Conference of American States (better known as the *Pan-American Conference*) met in Washington, D.C., in 1889 and 1890. This conference was the first to include all the independent countries of the Western Hemisphere. The delegates established the International Union of American Republics, with the Commercial Bureau of the American Republics as its central office. In 1910, the bureau became the Pan American Union. The five conferences between 1889 and 1933 met under a cloud of fear of the United States. At this time, the United States interfered in the affairs of several Latin-American countries, often by force.

Recognizing the need for better Latin-American relations, President Franklin D. Roosevelt started the Good Neighbour Policy. The seventh Pan-American Conference in Montevideo in 1933 agreed that no country had the right to intervene in the affairs of another. In 1936, at the Inter-American Conference for the Maintenance of Peace, held in Buenos Aires, the American republics agreed to cooperate in solving their disagreements.

The eighth Pan-American Conference met in Lima in 1938. This conference declared that any threat to "the peace, security, or territorial integrity of any American republic" was the concern of all.

In a 1947 conference at Rio de Janeiro, representatives drew up the Inter-American Treaty of Reciprocal Assistance, or *Rio Treaty,* which declared that an armed attack on one member is an attack against all. The ninth Inter-American Conference met at Bogotá, Colombia, in 1948. This conference set up the Organization of American States (OAS). The Pan American Union became the General Secretariat of the OAS.

In 1954, the 10th Inter-American Conference adopted an anti-Communist resolution at the urging of the United States. In 1960, 19 American countries approved the Act of Bogotá, agreeing to work for the social and economic advancement of Latin-American nations. Also in 1960, the OAS took its first collective action against a country. It imposed diplomatic sanctions against the Dominican Republic, then under the control of dictator Rafael Trujillo.

In 1961, the United States and Latin American countries established the Alliance for Progress. This programme called for social and economic development based on democracy and capitalism.

In 1962, the OAS unanimously supported a United States naval blockade aimed at preventing Soviet nuclear weapons from entering Cuba. In 1969, an OAS conference of foreign ministers swiftly ended an invasion of Honduras by El Salvador.

Amendments to the OAS charter went into effect in 1970. They provided for a General Assembly that would meet annually. The assembly replaced the Inter-American Conference, which had usually held regular sessions every five years. Since the late 1970's, the OAS has struggled to reduce revolutionary and other political turmoil in Central America. But it has had little effect.

See also **Organization of American States; Pan American Highway; Pan American Union.**

**Pan American Games** are a series of athletic contests, patterned after the Olympic Games and sponsored by the Pan American Sports Organization, made up of 38 Western Hemisphere nations. The games are usually held every four years. See also **Olympic Games.**

The Pan American Games were inaugurated after World War II (1939-1945) by the Pan American Sports Congress as a way to increase good will among the countries of the Americas. The game sites have been Buenos Aires, Argentina (1951); Mexico City (1955 and 1975); Chicago (1959); São Paulo, Brazil (1963); Winnipeg, Canada (1967); Cali, Colombia (1971); San Juan, Puerto Rico (1979); Caracas, Venezuela (1983); Indianapolis, U.S.A. (1987); Havana, Cuba (1991); and Argentina (1995).

**Pan American Highway** is a system of major roads that extends from the United States-Mexican border to southern Chile. It also connects the east and west coasts of South America, and links the capitals of 17 Latin-American countries. The 47,516-kilometre system benefits Latin America's economy. It provides a route for raw materials and agricultural products through much of Latin America. The Pan American Highway is sometimes described as running through the western United States and Canada up into Alaska. But neither country has officially named any major road as part of the Pan American Highway system.

**Route.** The Pan American Highway has four major U.S. terminals: Nogales, Arizona; and Eagle Pass, El Paso, and Laredo, Texas. It crosses Mexico, Guatemala, El Salvador, Honduras, Nicaragua, and Costa Rica, and continues into Panama. The Darién Gap, a stretch of about 140 kilometres of jungle, blocks the road at Yaviza, Panama. Motorists usually ship their cars between either Cristóbal or Balboa, Panama, and Colombia or Venezuela. South of the gap the road follows South America's western coast to Puerto Montt, southern Chile.

At Santiago, Chile, about 1,060 kilometres north of Puerto Montt, a major branch of the road cuts eastward across the Andes Mountains to Buenos Aires, Argentina. From Buenos Aires, it follows the east coast of South America north to Rio de Janeiro, Brazil, then turns inland to Brasília, the capital of Brazil. Other branches lead to the capitals of Bolivia (La Paz and Sucre), Paraguay (Asunción), and Venezuela (Caracas).

**Development.** The idea to link North and South America dates from the late 1800's, when people talked of building a Pan American railway. But it was not until 1923, at the Fifth International Conference of American States, that a road was seriously considered. This conference led to the First Pan American Highway Congress at Buenos Aires in 1925.

Organization of the system started in the late 1920's. By 1940, over 60 per cent of the road between the

**Pan American Highway**

The Pan American Highway provides a route through much of Latin America for raw materials and agricultural products. It links the capitals of 17 countries and connects the east and west coasts of South America.


United States and Panama had been completed. By the early 1950's, most of the project was open to travel in South America. In 1962, an important link in the system, the Thatcher Ferry Bridge, was completed over the Panama Canal at Balboa. The bridge is 1.6 kilometres long and is one of the world's longest steel arch bridges.

Each South American country has financed the building of the road within its own borders. In 1930, the United States began giving financial support to speed the building of the Pan American Highway between Panama and Texas. This section is also called the Inter-American Highway. The United States has contributed two-thirds of the cost of building this part of the highway. Only Mexico has not used United States financial aid in building the portion of the highway within its borders.

The Pan American Highway Congress, sponsored by the Organization of American States (OAS), meets every four years to discuss the development and progress of the highway. The congress has its headquarters in the General Secretariat of the OAS in Washington, D.C.

See also **South America** (Transportation [picture]).

**Pan American Union** was the former name of the permanent body of the Organization of American States (OAS). The OAS is an association of countries of North, Central, and South America. The name Pan American Union was abandoned in 1970, when amendments to the OAS charter took effect. The OAS then named its permanent body the General Secretariat.

The Pan American Union developed from an organization that was established in 1890. In that year, the First International Conference of American States created the International Union of American Republics, with the Commercial Bureau of the American Republics as its central office. The Commercial Bureau was renamed the Pan American Union in 1910.

In 1948, the nations belonging to the Pan American Union created the Organization of American States. The Pan American Union became the permanent and central organ and the General Secretariat of the OAS. It was also the permanent body of the Inter-American Conferences of the OAS.

The Pan American Union helped to bring many benefits to the peoples of American nations. The Pan American Postal Union grew out of friendly inter-American discussion. The famous Pan American Highway now links the United States with Mexico and countries of Central and South America.

See also **Organization of American States; Pan-American conferences; Pan American Highway.**

# Panama

**Panama** is a small country in Central America that has worldwide importance as a transportation centre. It covers the Isthmus of Panama, a narrow strip of land that separates the Atlantic and Pacific oceans near the middle of the Western Hemisphere. The Panama Canal cuts through the isthmus, connecting the two oceans. Thousands of ships use the canal each year to pass from one ocean to the other. By doing so, they avoid a long trip around the southern tip of South America. Thus, Panama plays a key role in the world's transportation system. The country is sometimes called the *Crossroads of the World* because of this role, which it has played since 1914.

Panama lies at the southern end of North America. It and the land north of it to Mexico's southern border make up the part of the North American continent called Central America. Panama is a narrow country that curves from west to east. The Atlantic Ocean lies to the north, the Pacific Ocean to the south, Colombia to the east, and Costa Rica to the west.

Lowlands cover the part of Panama near the Atlantic and Pacific coasts. The Atlantic coast is sometimes referred to as the Caribbean coast because it borders the part of the Atlantic Ocean that is called the Caribbean Sea. Mountains cover much of Panama's interior, and there are jungles and swamps in the east. Panama City is the country's capital and largest city.

*Mestizos* (people of mixed American Indian and white ancestry) and *mulattoes* (people of mixed black and white ancestry) make up more than two-thirds of the population of Panama. Most of the rest of the people of Panama are of unmixed American Indian, black, or white ancestry.

American Indians were the first inhabitants of what is now Panama. Spaniards conquered the Indians during the 1500's and ruled Panama for about 300 years. In 1821, Panama broke away from Spain and became a province of the nation of Colombia. In 1903, it rebelled against Colombia and became an independent nation.

**Facts in brief about Panama**

**Capital:** Panama City.
**Official language:** Spanish.
**Official name:** República de Panamá (Republic of Panama).
**Area:** 78,200 km². *Greatest distances*—east-west, 660 km; north-south, 209 km. *Coastline*—Atlantic Ocean, 639 km; Pacific Ocean, 1,201 km.
**Elevation:** *Highest*—Volcán Barú, 3,475 m above sea level. *Lowest*—sea level along the coasts.
**Population:** *Estimated 1996 population*—2,704,000; density, 35 people per km²; distribution, 53 per cent urban, 47 per cent rural. *1990 census*—2,329,329. *Estimated 2001 population*—2,936,000.
**Chief products:** *Agriculture*—bananas, rice, sugar cane, beef cattle, milk, coffee, maize, chickens and eggs, beans. *Manufacturing*—beverages, cement, petroleum products, processed foods. *Fishing*—shrimp, anchovetta.
**National anthem:** "Himno Nacional de la República de Panamá" ("National Hymn of the Republic of Panama").
**Money:** *Currency unit*—balboa. One balboa = 100 centésimos.

**Panama** is famous as the site of the Panama Canal, one of the world's most important waterways. Thatcher Ferry Bridge, *above,* crosses the canal near Panama City, the country's capital.

The United States played a major role in Panama's history. It built the Panama Canal, which was completed in 1914. Many U.S. civilians and soldiers then moved to Panama to guard, operate, and maintain the canal. They lived in a special area bordering the canal called the Panama Canal Zone. The United States took control of the canal and the zone in exchange for payments to Panama. In 1977, Panama and the United States signed a treaty that resulted in the transfer of the Canal Zone to Panama in 1979. The treaty also provided for the transfer of the canal to Panama on Dec. 31, 1999. For details on the canal and the Canal Zone, see **Panama Canal; Panama Canal Zone.**

Merchant ships from many countries find it convenient to sail under the Panamanian flag. This is because Panamanian ship taxes and wages are low.

### Government

According to its Constitution, Panama is a republic. The Constitution grants the people such rights as freedom of speech and religion. Panamanians 18 years of age or older may vote in elections.

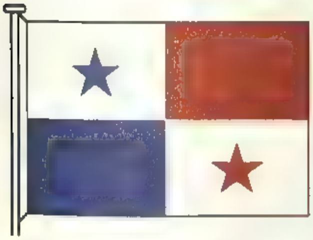
**National government** of Panama is headed by a president. The president is elected to a five-year term by the people. A Cabinet assists the president in carrying out the operations of the government. The National Assembly makes the country's laws. The people elect the members of the National Assembly to five-year terms.

**Local government.** Panama is divided into nine provinces for purposes of local government. The provinces are subdivided into municipal districts. The president appoints a governor to head each province. The people elect district mayors and councils.

**Politics.** The Authentic Panamenista Party is Panama's largest political party. Other large parties include the Christian Democratic Party, the Democratic Revolutionary Party, and the Nationalist Liberal Republican Movement.

**Courts.** The Supreme Court is Panama's highest court. It hears appeals from lower courts. It has nine members, who are appointed by the president to 10-year terms. Panama's lower courts include superior, circuit, and municipal courts.

**Armed forces.** Panama has no regular armed forces. Security is provided by the Public Forces. These civilian forces are the National Police, the National Air Service, and the National Maritime Service. Together they have about 13,000 members. Service is voluntary.



**Panama's flag** was adopted in 1903. Its blue star stands for honesty and purity. The flag's red star symbolizes authority and law.

**The country's coat of arms** bears Latin words meaning *For the Benefit of the World.* This motto refers to the role of the Panama Canal.


**Panama** occupies a narrow strip of land between the Pacific Ocean and the Caribbean Sea, a part of the Atlantic Ocean.

**Cuna Indian children** dance and play musical instruments during a celebration in their village. They live on one of the San Blas Islands off the northern coast of Panama's mainland.

## People

**Population and ancestry.** Panama has a population of about 2½ million. The population is growing at a rate of about 2 per cent a year. About 55 per cent of the people live in urban areas, and about 45 per cent live in rural areas. Panama's largest cities are—in order of population—Panama City, San Miguelito, and Colón. Together, these three cities have about 75 per cent of the country's urban population.

Panama has an ethnically mixed population. American Indians were its first inhabitants. In the 1500's, Spaniards became the first whites to reach Panama. They took black slaves from Africa to Panama. In the 1800's, many blacks of African descent left the West Indies to settle in Panama. Over the years, Indians, whites, and blacks intermarried. Today, about two-thirds of Panama's people are descendants of more than one group. The largest mixed groups are mestizos and mulattoes. Together, they make up about 70 per cent of the population. Blacks and whites each make up from 10 to 15 per cent, and Indians about 6 per cent.

**Way of life.** The part of Panama near the Panama Canal is a busy centre of urban activity. In contrast, most of the rest of the country is made up of quiet rural areas of farms, tiny villages, and small towns.

Panama City lies at the Pacific end of the Panama Canal, and Colón is at the Atlantic end. These cities are active centres of commerce, trade, and transportation. They have many modern, high-rise office buildings, and hotels, nightclubs, bars, and gambling establishments. Their main streets are crowded with foreign traders, sailors, and tourists, as well as Panamanians. The Panama Canal and the 16-kilometre-wide area that was formerly called the Panama Canal Zone lie between Panama City and Colón. Over the years, people from the United States, called Zonians, established communities that resemble United States towns and suburbs in this area. The communities include Balboa and Cristóbal.

Most of Panama's white people live in the area near the Panama Canal. Many of the whites are extremely wealthy. A small group of Panama's people, most of

them wealthy whites, are called the *elite.* Their families have had wealth for several generations. The elite take great pride in their traditions, and they tend to avoid social contact with other Panamanians. This group includes many large landowners, and also doctors, lawyers, and political and military leaders. The elite control Panama's economic and political systems.

Many other whites and also many mestizos and mulattoes of the Panama Canal area belong to the middle class. They include merchants, government officials, and office workers. Most of Panama's black people live near the canal. Large numbers of the blacks are poor labourers. As in many other countries, the blacks suffer from discrimination in job opportunities.

Most Panamanians who live away from the Panama Canal area are farmers. Mestizos and mulattoes form the majority of the country's farm population. They make their homes in small villages or on farm fields, primarily in the western part of the country. Many Panamanian farming families must struggle to produce enough food for their own use.

Most of Panama's Indians live in rural areas. The main Indian groups are the Chocó, Cuna, and Guaymí. Cuna Indians who live on the San Blas Islands off Panama's northern coast are sometimes called San Blas Indians. Panama's Indians farm and fish for a living.

Traditionally, Panamanian women have had little opportunity for higher education or careers. They have been expected to marry early, raise large families, and manage their household. Since the mid-1900's, however, more and more women have taken jobs outside the home.

**Housing.** Wealthy Panamanians live in large houses built in either the Spanish colonial or a modern architectural style, or in large luxury apartments. Most middle-class people have smaller houses or apartments. Panama's poor urban people live in shacks or run-down apartments.


## Panama map index

### Provinces*

| | | | |
|---|---|---|---|
| Bocas del Toro | 73,302 | A | 2 |
| Chiriquí | 345,749 | B | 2 |
| Coclé | 159,105 | B | 4 |
| Colón | 187,706 | A | 4 |
| Darién | 36,072 | B | 6 |
| Herrera | 98,206 | C | 4 |
| Los Santos | 80,635 | C | 4 |
| Panamá | 956,782 | B | 5 |
| Veraguas | 203,907 | C | 3 |

### Cities and towns

| | | | |
|---|---|---|---|
| Aguadulce | 11,087 | B | 4 |
| Almirante | 7,047 | A | 2 |
| Antón | 5,987 | B | 4 |
| Arraiján | 16,272 | B | 5 |
| Atalaya* | 4,456 | C | 3 |
| Bajo Boquete | 9,164 | B | 1 |
| Balboa | 1,104 | B | 5 |
| Bocas del Toro | 4,363 | A | 2 |
| Bugaba* | 14,552 | B | 1 |
| Calobre | 2,237 | B | 3 |
| Cañazas | 6,627 | B | 3 |
| Capira | 3,074 | B | 4 |
| Changuinola | 18,911 | A | 1 |
| Chepo | 6,385 | A | 5 |
| Chitré | 17,315 | C | 4 |
| Colón | 59,840 | A | 4 |
| David | 50,016 | B | 1 |
| Dolega | 4,648 | B | 1 |
| El Valle | 3,827 | B | 4 |
| Gualaca | 4,286 | B | 2 |
| Guararé | 2,761 | C | 4 |
| Hato del Volcán | 4,997 | B | 1 |
| La Arena* | 3,809 | C | 4 |
| La Chorrera | 21,106 | B | 4 |
| La Mesa | 3,474 | C | 3 |
| Las Cumbres* | 31,495 | B | 5 |
| Las Palmas* | 3,480 | C | 3 |
| Las Tablas | 5,235 | C | 4 |
| Los Pozos | 2,077 | C | 3 |
| Los Santos | 5,604 | C | 4 |
| Monagrillo | 5,699 | C | 4 |
| Montijo | 4,070 | C | 3 |
| Natá | 5,185 | B | 4 |
| Ocú | 6,103 | C | 3 |
| Panama City | 389,172 | B | 5 |
| Penonomé | 9,291 | B | 4 |
| Pocrí | 5,987 | B | 4 |
| Portobelo | 2,774 | A | 5 |
| Puerto Armuelles | 37,123 | B | 1 |
| Puerto Pilón | 8,460 | A | 4 |
| Río de Jesús | 3,644 | C | 3 |
| San Miguelito | 156,611 | B | 5 |
| Santa María | 2,077 | C | 3 |
| Santiago | 32,427 | C | 3 |
| Soná | 7,700 | C | 3 |
| Tolé | 5,043 | B | 2 |

*Does not appear on the map; key shows general location.

### Physical features

| | | |
|---|---|---|
| Chagres River | A | [illegible] |
| Coiba Island | C | [illegible] |
| Colón Island | A | [illegible] |
| Darién Mountains | B | [illegible] |
| Gatun Lake | A | [illegible] |
| Mosquitos Gulf | B | [illegible] |
| Panama Canal | B | [illegible] |
| Rey Island | B | [illegible] |
| San Blas Islands | A | [illegible] |
| San Blas Mountains | A | [illegible] |
| Tabasará Mountains | B | [illegible] |
| Tulra River | C | [illegible] |
| Volcán Barú (volcano) | B | [illegible] |

**A street scene in Colón** shows people of various races. Most Panamanians are of mixed Indian and white, or black and white, descent. Others are of black, Indian, or white ancestry.

**Traditional costumes** are worn by many Panamanians on special occasions. The woman above wears a colourful *pollera* while dancing at a fiesta. The man's shirt is called a *camisilla.*

The majority of rural Panamanians live in small one- or two-room houses. Many houses near the Pacific coast have thatched roofs, and walls made from sugar cane stalks. Others are made from branches that are held together with clay or mud. Many of the houses near the Atlantic coast are made of wood.

**Clothing.** Most Panamanians wear Western-style clothing most of the time. On holidays and other special occasions, large numbers of people dress in special costumes. Women may wear a *pollera,* a white garment consisting of a blouse and long full skirt that are decorated with lace and embroidery. Or, they may wear a costume of a white blouse and brightly coloured skirt called a *montuna.* Men may wear a *montuno,* which consists of a white embroidered shirt and short trousers. A *camisilla* (long, white shirt) and long trousers is another special costume worn by men.

Many Panamanian farmers wear straw hats while working. These hats, which are made in Panama, are sometimes mistakenly called *Panama hats.* But Panama hats are made in Ecuador, and are not worn by many Panamanians. They received the name Panama hats during the 1800's, when Panama became a centre for the shipment of the hats to other countries.

Panama's Indians, especially women of the San Blas group, are proud of their colourful costumes. San Blas women wear brightly coloured garments with elaborate embroidery. They also wear a ring that hangs from the nose and large metal discs for earrings.

**Food and drink.** Rice is the basic food of most Panamanians. Many of the people cook rice with beans to make a dish called *guacho. Tortillas* (flat breads made from maize or wheat flour) are another favourite food. Coffee and beer are popular beverages.

**Recreation.** Music is a favourite form of recreation in Panama. Most Panamanians enjoy musical performances, and many play instruments for recreation. Celebrations called *fiestas* are held on holidays. Fiestas feature religious rituals, dancing, music, and special meals. Baseball is the most popular sport in Panama, and basketball is also popular. Panamanians learned about these sports from people from the United States who moved to the country after the Panama Canal opened. Soccer is also popular.

**Languages.** Spanish, Panama's official language, is spoken by nearly all the people. Some Indian groups use their own local language in addition to Spanish. Many Panamanians can speak English.

**Religion.** About 95 per cent of Panama's people are Roman Catholics. Most of the rest of the people are Protestants. The Catholic Church plays an important role in Panama. Church services and celebrations are both religious and social events for many of the people.

**Education.** About 90 per cent of Panama's adults can read and write. The law requires children to attend school between the ages of 7 and 15, or until they complete the sixth *grade* (class). But about half the children leave school before completing the requirement. Most of these children are from poor families and leave school to begin work. About half the students who complete the sixth grade also complete secondary school. Panama has two universities, both in Panama City. They are the University of Panama and the University of Santa María la Antigua.

**Housing in Panama's cities** varies widely. In the scene above in Panama City, old, shabby shacks stand near large, modern apartment buildings.

### Land and climate

Panama covers the Isthmus of Panama, which has an area of about 78,200 square kilometres. The isthmus extends about 660 kilometres from west to east. From north to south, it measures only about 210 kilometres at its widest point and 48 kilometres at its narrowest point.

The Panama Canal cuts through the centre of the country, dividing the land into eastern and western sections. About 98 per cent of the people live near the canal or in the part of the country west of it. Swamps and jungles cover much of Panama east of the canal. Only about 2 per cent of the people, chiefly Indians, live in the east.

Many wild animals live in Panama. They include jaguars, ocelots, pumas, monkeys, and parrots and other tropical birds. Pine trees are abundant in Panama's mountains. Banana plants and cacao trees are grown in many parts of the country.

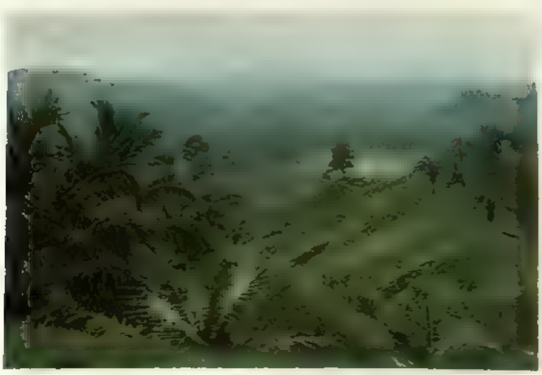
Panama has three land regions—the Central Highland and coastal lowlands called the Atlantic Lowland and the Pacific Lowland.

**The Central Highland** is a mountainous region. The Tabasará Mountains extend eastward from the Costa Rican border. The country's highest peak, 3,475-metre Volcán Barú rises near the border. The mountain range decreases in height as it extends eastward. It is made up of low hills near the Panama Canal. Panama's land rises to mountains again east of the canal. The San Blas Mountains and Darién Mountains, the main ranges in the east, reach heights of about 1,800 metres. Valleys between the mountains in western Panama provide much good farmland.

**The coastal lowlands** are narrow areas that lie along Panama's Pacific and Atlantic coasts. The Pacific Lowland has much fertile farmland, which is located chiefly in the west. The Atlantic Lowland is less fertile.

**Coastline and islands.** Panama's Pacific coastline measures 1,200 kilometres. The Atlantic coastline is 640 kilometres long. About 800 islands that lie near the coasts are part of Panama's territory. The largest are Coiba Island and Rey Island, both off the Pacific coast.

**Rivers and lakes.** Panama has about 500 rivers. But only one river, the Tuira, is navigable for long distances. The Tuira flows for 200 kilometres in eastern Panama. Panama has no large natural lakes. Its largest lake is the 420-square-kilometre Gatun Lake, which was created by the builders of the Panama Canal and forms part of the canal route.



**The Central Highland,** *above,* is a region that covers much of Panama inland from the Atlantic and Pacific coasts. The areas near the coasts are flatter than the rugged highland.

**Climate.** Most of Panama has a warm, tropical climate that varies little from season to season. Temperatures in the lowlands average about 27° C. Mountain temperatures average about 19° C. The Atlantic side of Panama receives about 380 centimetres of rain annually. About 175 centimetres of rain falls on the Pacific side yearly.

### Economy

Economic activity in Panama varies according to location. Near the Panama Canal, the economy is based on business generated by the waterway, and on commerce, trade, manufacturing, and transportation. In most other places, the economy is based on agriculture.

The Panama Canal is the most important single factor in the country's economy. But agriculture employs more people than does any other single economic activity. The economy operates as a free enterprise system.

**The Panama Canal.** The Panama Canal Commission, a U.S. government agency, collects tolls from ships that pass through the Panama Canal. It pays the Panamanian government an annual fee and a percentage of the toll money. The total payment to Panama's government is about 75 million U.S. dollars a year.

The Panama Canal also directly and indirectly provides jobs for many Panamanians. The jobs include positions related to the operation and maintenance of the canal. They also include jobs in shops and other businesses that exist because of the economic activity generated by the canal.

**Commerce and trade** flourish near the Panama Canal. Colón and Panama City are among Latin America's chief banking centres. Colón has a Free Trade Zone, where merchants can import and export goods without paying *duties* (taxes). Many merchants send goods to Colón and then export them to other countries to save money. More than 300 import and export companies operate in the Free Trade Zone.

**Manufacturing.** About two-thirds of Panama's manufacturing firms are located in Panamá Province, just west of the canal. The country has few large manufacturing industries. Its chief products include beer, cement, and cigarettes. Panama has many plants that process food, including fish, fruit, milk, and sugar. An oil refinery located near Colón processes crude oil from other countries into petroleum products.

**Agriculture** employs about a fourth of Panama's workers. Most of these workers farm a small plot of land and use old-fashioned agricultural equipment and methods. The majority of the farmers produce only *subsistence crops*—that is, crops grown by farmers for their own use. Rice is the main subsistence crop, followed by maize and beans. Bananas are the chief *cash crop.* Cash crops are those that are grown for sale. Other cash crops include sugar cane, coffee, and tobacco. Cattle ranching is another important agricultural activity. Panamanian farmers also raise chickens and pigs.

Most Panamanians who raise subsistence crops own or rent their farms. But many of them are *squatters.* Squatters neither own nor rent the land they farm. Instead, they simply settle on land owned by the govern-

ment or private citizens and farm it. Most of Panama's cash crop production takes place on large farms owned by wealthy landowners. The landowners hire agricultural workers to farm their land.

**Fishing.** Shrimp is the most important product of Panama's fishing industry. Anchovetta, a small fish that is ground into fish meal, ranks second. Other catches include herring and lobster.

**Mining.** Panama's small mining industry centres on the production of such construction materials as lime, sand, and crushed stone. Large copper deposits lie near Colón and David, but they are undeveloped.

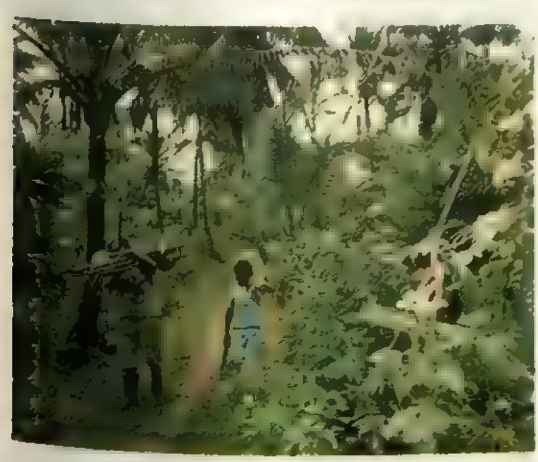
**Foreign trade.** Bananas, shrimp, and sugar are Panama's chief exports. Imports include cars, chemicals, machinery, and petroleum. The United States is Panama's chief trading partner. Panama also carries on a lot of trade with Japan, Venezuela, and several Western European countries.

**Transportation and communication.** Panama is a major centre of international transportation by sea and air. About 12,000 ships pass through the Panama Canal yearly. Cristóbal, a suburb of Colón; and Balboa, a suburb of Panama City, are busy international ports. The main airport is at Tocumen, near Panama City.

Panama's merchant marine is one of the largest in the world. About 5,300 ships fly the Panamanian flag. Shipping lines of other countries own most of the ships. They register the ships in Panama because Panama allows them to pay lower taxes and wages than do their own countries, and to avoid some safety regulations.

Only about a third of Panama's road system is paved. Most rural roads in Panama have an earth surface. The country's major road is the Panamanian section of the Pan American Highway. It runs from the Costa Rican border to the eastern part of the country. Another important road in Panama is the Trans-Isthmian Highway between Colón and Panama City. Railways link Panama's cities and towns.

Panama has six daily newspapers. The country has about 1 radio for every 7 people and about 1 television set for every 8 people.



**A farmer and his son** carry home sugar cane and coconuts they have gathered. Agriculture employs more Panamanians than does any other activity. Most farming is on a small scale.

## History

**Early days.** Indians were the first inhabitants of what is now Panama. The Indians farmed, fished, and hunted.

**The Spanish colonial period.** Spain took control of what is now Panama from the Indians during the early 1500's. In 1501, Rodrigo de Bastidas, a Spanish explorer, became the first white person to reach the area. In 1502—during his fourth voyage to the New World—Christopher Columbus, an Italian navigator employed by Spain, landed in what is now Panama. He claimed the area for Spain. A group of Spanish soldiers and colonists reached Panama in 1510. The Spaniards established colonies along the Atlantic coast. The Indians told the Spaniards of a large body of water that lay across the Isthmus of Panama, not far away. The body of water was actually the Pacific Ocean. Vasco Núñez de Balboa, acting governor of the colonies, led an expedition across the isthmus. On Sept. 25, 1513, he became the first white person to see the eastern shore of the Pacific.

The fact that Panama was only a narrow strip of land between the Atlantic and Pacific made the area important to the Spaniards. Sailing from military bases they established along the Panamanian Pacific coast, the Spaniards explored the west coast of Latin America. They conquered many of the Indian lands they reached. The most important conquest took place in the 1530's, when Spaniards led by Francisco Pizarro defeated the Inca of Peru. The Spaniards took great treasures of gold and other riches from the Inca and from other Indians. Spain built a stone road across Panama to transport the treasures from the Pacific to the Atlantic coast. The treasures then were shipped to Spain.

The Spaniards did little to develop Panama's economy. They treated the Indians harshly and killed many of them. Under Spain, Panama became a centre for the distribution of black African slaves in the New World.

In the 1600's, the Englishman Henry Morgan and other pirates attacked Spanish ships and towns in Panama. Many Spanish ships carrying goods from Peru began sailing around the tip of South America to avoid the pirates. Panama declined as a transportation centre.

**Colombian rule.** Colombia gained independence from Spain in 1819. In 1821, Panama broke away from Spanish rule and became a province of Colombia.

A gold rush began in California in 1848. People from the eastern United States began sailing to Panama, crossing the isthmus to the Pacific, and then sailing on to California to reach the gold rush area.

Businessmen from the United States built a railway across Panama to speed up passage across the isthmus. The railway was completed in 1855. Large numbers of people began using it to cross the isthmus quickly, and Panama again became a busy transportation centre.

Many labourers from other countries moved to Panama to help build the railway. They included thousands of blacks from the West Indies. Many of the black labourers settled permanently in Panama.

Relations between Panama and the rest of Colombia were always strained, and, beginning in 1830, Panamanians staged several revolts against Colombia. In 1903, Colombia refused an offer by the United States to build a canal across Panama. Panama, encouraged by the United States, then revolted against Colombia. It became an in-

dependent nation on Nov. 3, 1903. The United States hoped to gain approval to build the canal from the newly independent country. It sent ships and troops to protect the new government against an overthrow by Colombia. The United States, with Panama's approval, then began building the canal.

**Progress as a nation.** The Panama Canal was opened on Aug. 15, 1914. It brought prosperity to the part of Panama near the waterway. The United States established the former Panama Canal Zone there. The economies of the Panama Canal Zone, Colón, and Panama City flourished. Many Panamanians moved to the canal area to find jobs. But the changes near the canal had little effect on other parts of Panama. Most of the country remained rural and underdeveloped.

Political rivalries brought instability to Panama's government during the early and mid-1900's. Rival groups struggled for control of the country, and the government changed hands many times.

**Relations with the United States.** Many Panamanians opposed U.S. control of the Panama Canal and Panama Canal Zone. They demanded Panamanian control. In the 1950's and 1960's, Panamanians staged many demonstrations and some riots against U.S. control.

In 1968, Brigadier General Omar Torrijos Herrera, the head of the military, took control of Panama and began to rule as a dictator. He strengthened the movement to end U.S. control of the Panama Canal and Panama Canal Zone. In 1977, after several years of negotiations, Panama and the United States signed a treaty designed to end U.S. control. The treaty resulted in the transfer of the Panama Canal Zone to Panama in 1979. It also provided for the transfer of the Panama Canal to Panama on Dec. 31, 1999.

**Panama today** faces a period of major change. The transfer of the canal and Canal Zone probably will have major effects on the country's economy. Panamanian government and business leaders are planning to establish new manufacturing and processing plants and other businesses in the zone. Also, jobs held by United States citizens that are related to the operation and maintenance of the canal gradually will be taken over by Panamanians. These developments provide opportunities for much economic progress for Panama.

But the transfer of the Panama Canal and the Panama Canal Zone also presents challenges to Panama. The canal's operation and maintenance requires many technical skills. Panamanians must be trained in the skills to run the canal efficiently. Also, investments and spending by the United States government and U.S. citizens will probably decrease along with U.S. involvement.

Panama also faces the challenge of improving the parts of its economy that are not related to the Panama Canal. The country has valuable resources, including forests, fishing grounds, and fertile farmland. But Panama's forestry, fishing, and agricultural industries have never been developed to their full potential.

General Torrijos gave up control of Panama's government in 1978. Civilian leaders took control, but Torrijos kept much power as head of the military. Torrijos died in a plane crash in 1981. The military continued to hold much power after his death.

In 1983, General Manuel Antonio Noriega became head of the military and Panama's most powerful leader. In 1987, a former aide of Noriega accused him of election fraud in the 1984 presidential election, of killing a political opponent, and of making large amounts of money through corruption. In 1988, two U.S. federal grand juries in Florida indicted Noriega on charges of drug trafficking and racketeering in the United States. Panamanian President Eric Arturo Delvalle dismissed Noriega from his military command, but Noriega supporters forced the president from office. The U.S. government denounced this action. It imposed extreme economic sanctions against Panama and called for Noriega's resignation.

In 1989, Panama held a presidential election. Guillermo Endara, a politician opposed to Noriega, apparently won the election. But the Panamanian government declared the election invalid. On Oct. 3, 1989, a group of Panamanian soldiers tried to overthrow Noriega, but failed. The United States provided minor aid to the rebels by blocking some key roads. In December 1989, Panamanian soldiers killed a United States marine lieutenant. Mentioning this incident and the drug trafficking charges, U.S. President George Bush ordered troops into Panama to overthrow Noriega. In January 1990, Noriega surrendered to United States officials. Endara was named president of Panama, and a new civilian government was formed. In 1992 a Miami court found Noriega guilty of trafficking in cocaine and he received a 40-year prison sentence.

**Related articles** in *World Book* include:

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| Balboa, Vasco Núñez de | Colón | Panama Canal |
| Central America | Columbus, Christopher | Panama Canal Zone |
| Chagres River | Herrera, Tomás | Panama City |

**Outline**

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**Questions**

Why is Panama called the *Crossroads of the World*?
What is a *pollera*? A *montuna*? A *montuno*?
How does the Panama Canal help Panama's economy?
How does the way of life differ near the Panama Canal and away from it?
What are Panama's main crops?
How has the United States influenced life in Panama?
Why was Panama important to the Spaniards?
What is the most popular sport in Panama?
What changes does Panama face today?

**Panama, Isthmus of.** See Panama (introduction; Land and climate).

**The Panama Canal** is an artificial waterway that cuts across Central America and links the Atlantic and Pacific oceans. The canal enables ships to travel between Atlantic and Pacific ports without sailing around South America, saving a distance of up to 12,600 kilometres.

**Panama Canal** is a waterway that cuts across the Isthmus of Panama and links the Atlantic Ocean and the Pacific Ocean. It ranks as one of the greatest engineering achievements in the world. Upon its completion in 1914, the canal shortened a ship's voyage between New York City and San Francisco to less than 8,370 kilometres. Previously, ships making this trip had to travel around South America—a distance of more than 20,900 kilometres.

The United States built the Panama Canal at a cost of about 380 million U.S. dollars. Thousands of labourers worked on it for about 10 years, using steam shovels and dredges to cut through jungles, hills, and swamps. They had to conquer such tropical diseases as malaria and yellow fever.

The Panama Canal extends 81.63 kilometres from Limón Bay on the Atlantic Ocean to the Bay of Panama on the Pacific Ocean (see **Panama** [map]). A ship travelling through the canal from the Atlantic to the Pacific sails from northwest to southeast. The ship actually leaves the canal 43 kilometres east of where it entered.

The canal has three sets of waterfilled chambers called *locks,* which raise and lower ships from one level to another. The locks were built in pairs to allow ships to pass through in both directions at the same time. Each lock has a usable length of 300 metres, a width of 34 metres, and a depth of about 20 metres. The dimensions of the locks limit the size of ships that can use the canal. For example, commercial supertankers and the supercarriers of the U.S. Navy cannot pass through it.

A 1903 treaty between the United States and Panama gave the United States the right to build and operate the waterway. The United States also received the right to govern an area of land called the Panama Canal Zone on both sides of the canal. For many years, Panama tried to gain control of the canal and the zone. In 1977, Panama and the United States signed a new treaty. As a result of this treaty, Panama received territorial jurisdiction over the zone in 1979. The United States kept administrative control of some military installations and areas necessary to operate and defend the canal. The treaty also provided for Panama to take control of the operations of the canal and its associated military installations on Dec. 31, 1999. A second treaty gave the United States the right to defend the neutrality of the canal.

### A trip through the canal

**Entering the canal.** A ship sailing from the Atlantic Ocean enters the canal by way of Limón Bay, the harbour of the town of Cristóbal, near the city of Colón.


**The Panama Canal** shortens sea voyages between the Atlantic and Pacific oceans. A ship sailing between New York City and San Francisco, California, U.S.A. saves about 12,600 kilometres by using the canal rather than travelling around South America.

While the ship is still in deep water, a canal pilot comes on board from a small boat. The pilot has complete charge of the ship during its trip through the canal. After passing through the breakwater at the entrance to the bay, the ship heads south along the channel, 11 kilometres long, that leads to the Gatun Locks. The shipyards, docks, and fuelling stations of Cristóbal line the eastern shore of the bay.

**The Gatun Locks** look like giant steps. They consist of three pairs of concrete chambers that lift ships about 26 metres from sea level to Gatun Lake. Small electric locomotives called *mules* run on rails along both sides of the locks. They help to position and stabilize ships in the locks. They also pull and guide small ships through the locks. Large ships go through the locks chiefly under their own power. But locomotives help pull them, and also guide them.

As a small ship approaches the first chamber, its engines are shut off. A large ship keeps its engines on. Canal workers fasten the ends of the locomotives' towing cables to the vessel. The locomotives then pull a small ship, or help pull a large ship, into the first chamber. Huge steel gates close silently behind the vessel. Canal workers open valves that allow water from Gatun Lake to flow into the chamber through openings in the bottom of the lock. During the next 8 to 15 minutes, the rising water slowly raises the ship. When the level of the water is the same as the level of the water in the second chamber, the gates in front of the ship swing outward. The locomotives pull, or help pull, the vessel into the second chamber. Again the water level is raised. This process is repeated until the third chamber raises the ship to the level of Gatun Lake.

**Gatun Lake.** The canal workers release the cables, and the ship sails out of the locks under its own power. As it heads south across the quiet water of Gatun Lake, the ship passes the huge Gatun Dam to the west of the locks. This 18-million-cubic-metre earth dam is one of the largest in the world. Gatun Dam created the 422-square-kilometre Gatun Lake by holding back the waters of the Chagres River. This river flows into the Atlantic Ocean near the end of the Canal. The ship steams across the lake from Gatun Locks to Gamboa, following the 35-kilometre channel that was once the Chagres River Valley.

The tops of trees and hills jut above the water. They were almost submerged when engineers flooded the valley to create Gatun Lake. The violet flowers and green leaves of water hyacinths float on the lake. Their long, coarse stems can become tangled in ship propellers and endanger navigation. A special hyacinth patrol destroys more than 42 million plants a year to keep the channel clear.

**The Gaillard Cut.** When the ship reaches the southeastern end of Gatun Lake it enters the Gaillard Cut, 13 kilometres long and 150 metres wide. The cut has a minimum depth of 13 metres. *Cut* is an engineering term for an artificially created passageway or channel. The Gaillard Cut runs between Gold Hill on the east and Contractor's Hill on the west. The Gaillard Cut was originally called the *Culebra Cut.* In 1913, it was renamed in honour of David DuBose Gaillard, the engineer in charge of digging between the hills. Dredgers work constantly to keep the channel clear of earthslides. In some years, the dredgers in the Gaillard Cut remove as much as 750,000 cubic metres of earth. The Gaillard Cut

**The Panama Canal**

The Panama Canal cuts through the Isthmus of Panama. It is 81.63 kilometres long. At its narrowest point, Gaillard Cut, the canal is only 150 metres wide. The widest part of the canal route is the 422-square-kilometre Gatun Lake.


Road
Railway
National capital
Other city or town
Lock
Dam
Military base

0 5 10 Miles
0 5 10 Kilometres

is only wide enough for one-way traffic. In 1992, work began to widen it to accommodate two-way traffic. The project is expected to take about 20 years.

**The Pedro Miguel and Miraflores locks.** After the ship heads out of the Gaillard Cut, electric locomotives pull, or help pull, it into the Pedro Miguel Locks. These locks lower the vessel 9 metres in one step to Miraflores Lake. The ship sails 2.4 kilometres across the lake to the Miraflores Locks. Here, two chambers lower it to the level of the Pacific Ocean.

The distances these chambers must lower the ship depend on the height of the tide in the Pacific. Tides at the Pacific end of the canal rise and fall about 4 metres a day. Tides on the Atlantic side change only about 60 centimetres daily.

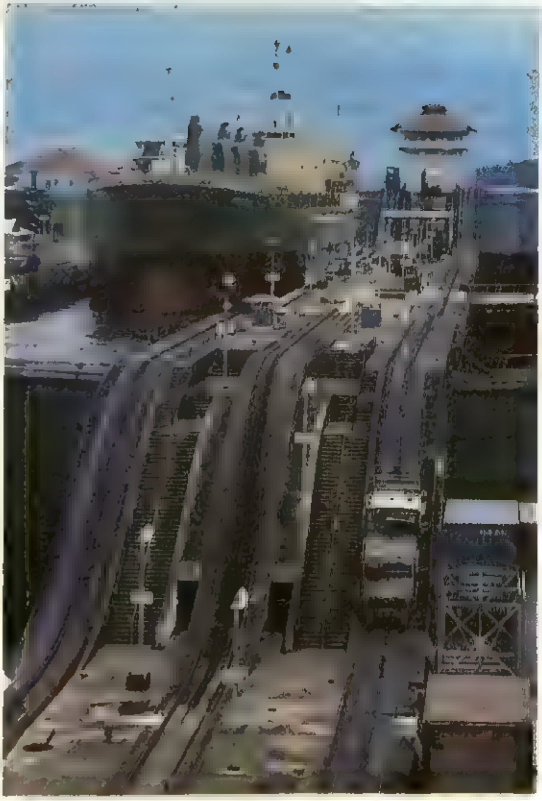
Out of the locks, the ship heads down a channel, 13 kilometres long, between the Miraflores Locks and the end of the canal. It passes the towns of Balboa, Balboa Heights, and La Boca. The ship also passes under the 20-million-U.S.-dollar Thatcher Ferry Bridge, which is an important link in the Pan American Highway. After the pilot leaves, the vessel enters the Bay of Panama and heads toward the open sea. It has travelled a little over 80 kilometres from the Atlantic to the Pacific in about eight hours.

### Importance of the canal

The Panama Canal is an important commercial and military waterway. About 12,500 oceangoing vessels travel through it yearly—an average of about 34 per day. The ships carry about 154 million metric tons of cargo annually.

About 70 per cent of the ships that sail through the canal are travelling to or from U.S. ports. Other frequent users of the canal include Canada and Japan.

The United States maintains several military bases to defend the canal. The U.S. Southern Command, which directs all U.S. military units in the Caribbean area, has its headquarters near the canal. Huge quantities of war materials and thousands of troops passed through the canal during World War II, the Korean War, and the Vietnam War.



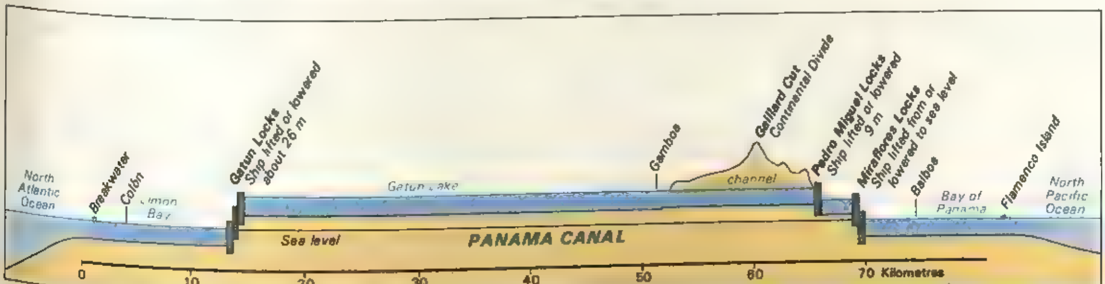
**The Gatun Locks** are chambers where the water level can be changed to raise or lower ships travelling through the Panama Canal. Electric locomotives, *right,* guide and help position ships in the lock chambers.

### Administration and defence

**The Panama Canal Commission** will operate and maintain the Panama Canal until Panama takes control of the waterway in 1999. The commission is a United States government agency. It has more than 7,000 employees, about 90 per cent of whom are Panamanian. The commission's board of directors consists of five Americans and four Panamanians. The Panama Canal Commission is responsible for the operation and maintenance of the waterway. In addition, the commission operates public utilities and provides community, sanitation, security, and transportation services.

**Finances.** The Panama Canal Commission collects tolls from ships that use the canal. The amount of the toll

**A profile of the Panama Canal** shows a ship's course through the waterway. A ship from the Atlantic Ocean is lifted by the Gatun Locks to the level of Gatun Lake. The ship crosses the lake and passes through the Gaillard Cut channel. The Pedro Miguel and Miraflores locks lower it to the level of the Pacific. The raising and lowering process is reversed for a ship from the Pacific.



paid by a merchant ship is determined by the ship's cargo space. Ocean-going vessels pay an average toll of about 32,000 U.S. dollars. Military ships must pay a toll based on their weight.

The Panama Canal Commission collects about 375 million U.S. dollars a year in tolls. It also collects about 175 million U.S. dollars a year in fees for providing tugboat, launching, and other marine services. From the total revenue, the United States must pay the expenses of operating the canal, including an annual payment to Panama of about 90 million U.S. dollars. This payment includes a fixed annual fee of 20 million U.S. dollars and an amount based on the tonnage of cargo that passes through the canal in a year.

**Defence.** International law requires that the United States allow commercial and military vessels of all nations to pass through the canal in peacetime. A treaty signed by the United States and Panama in 1977 guarantees that the canal will remain open to all nations even in time of war. The agreement gives the United States the right to use military force if necessary to protect the canal's neutrality.

### History

**Early efforts.** Hundreds of years before the Panama Canal was completed, people of many lands dreamed of building a canal across Central America. As early as 1517, Vasco Nuñez de Balboa, the first European to reach the Pacific, saw the possibility of a canal connecting the Atlantic and Pacific oceans.

Throughout most of the 1800's, Nicaragua was the chief centre of efforts to build a canal. Both the United States and Great Britain considered a canal across Nicaragua. During the 1840's, the two nations almost went to war because of disputes over which one would control the proposed canal. In 1850, in the Clayton-Bulwer Treaty, they agreed to protect the neutrality of a canal to be built somewhere across the Central American isthmus. See **Clayton-Bulwer Treaty.**

During that period, present-day Panama was a province of Colombia. Colombia feared that Great Britain would try to seize Panama for use as a canal site. Colombia signed a treaty with the United States in 1846. The United States agreed to guard all trade routes across Panama and to preserve Panama's neutrality.

**The Panama Railroad.** During the California gold rush that began in 1849, the Isthmus of Panama became an important route between the eastern United States and California. Many prospectors sailed from Atlantic Coast ports to Panama, crossed the isthmus by boat, on mules, and on foot, and then took another ship for California.

In 1850, Colombia permitted a group of business executives from New York City to build a railway across the isthmus. The line was completed in 1855 at a cost of 8 million U.S. dollars. It linked Colón on the Atlantic side and Panama City on the Pacific side.

**The French failure.** In 1878, Colombia granted a French adventurer named Lucien Napoleon Bonaparte Wyse the right to build a canal across Panama. He sold the right to a French company headed by Ferdinand Marie de Lesseps, who had directed the construction of the Suez Canal. The French also bought control of the Panama Railroad for 20 million U.S. dollars. The company began digging in 1882. The French planned a canal that would run at sea level between the Atlantic and Pacific, and so would need no locks. In 1886, the problems of building a sea-level canal forced the French to decide to build a canal similar to the present one. De Lesseps and his assistants planned most of the project carefully, and carried out some of it efficiently. However, the French wasted great quantities of material and effort. A group of dishonest politicians who supported De Lesseps stole large amounts of money from the canal company. The French engineers lacked the proper tools to complete such a huge digging job. In addition, scientists did not know how to fight the epidemics of tropical diseases that hit the workers.

De Lesseps' company went bankrupt in 1889, after digging out some 58 million cubic metres of earth. A second French firm, the New Panama Canal Company, took over the property and franchise in 1894. But the new company made only half-hearted efforts to continue digging, in order to keep the franchise until a buyer could be found.

**The United States and the canal.** A group of United States business executives began working on a canal across Nicaragua in 1889. But they ran out of money soon after beginning the project. Both the American and French groups tried to sell their rights and property to the United States government. But American railway executives opposed construction of any Central American canal because they feared competition from shipping lines that would use the canal. As a result, the United States government took no action on either project.

During the Spanish-American War in 1898, the United States Navy sent the battleship *Oregon* from San Francisco, California, U.S.A., to Cuba to reinforce the Atlantic Fleet. The *Oregon* had to sail nearly 20,900 kilometres around the tip of South America. The trip would have been only about 7,400 kilometres long through a canal. This fact helped convince the United States Congress that a canal was essential for national defence.

In 1899, the U.S. Congress authorized a commission to survey possible canal routes. The commission favoured Nicaragua, because a canal there would require less digging than one across Panama. But the French company offered to sell its Panama rights and property and the Panama Railroad for 40 million U.S. dollars. Philippe Bunau-Varilla, of the French company, persuaded leading Americans that Nicaragua's volcanoes presented the danger of earthquakes, and that Panama was safer. In 1902, Congress gave U.S. President Theodore Roosevelt permission to accept the French offer if Colombia would give the United States permanent use of a canal zone. Congress acted after the United States and the United Kingdom had replaced the Clayton-Bulwer Treaty with the Hay-Pauncefote Treaty. This treaty gave the United States sole right to build and operate a canal across Central America. See **Hay-Pauncefote Treaty.**

In 1903, United States Secretary of State John Hay signed a canal treaty with a Colombian representative, Tomás Herrán. The treaty provided that the United States would give Colombia an initial payment of 10 million U.S. dollars and pay 250,000 U.S. dollars annual rent for the use of the zone. But the Colombian legislature refused to approve the treaty because it felt that this was not enough money.

**President Theodore Roosevelt** visited the construction site of the Panama Canal in 1906. He wrote to his son about the Gaillard Cut, saying, "They are eating steadily into the mountain . . . ."

A group of Panamanians feared that Panama would lose the commercial benefits of a canal across the isthmus. The French company worried about losing the sale of its property to the United States. The Panamanians, with the help of the French and some encouragement from the United States, revolted against Colombia on Nov. 3, 1903, and declared Panama independent. In accordance with its 1846 treaty with Colombia, the United States sent ships to Panama to protect the Panama Railroad. Marines landed in Colón, and prevented Colombian troops from marching to Panama City, the centre of the revolution. On Nov. 6, 1903, the United States recognized the Republic of Panama. Less than two weeks later, Panama and the United States signed the Hay-Bunau-Varilla Treaty. It gave the United States permanent, exclusive use and control of a canal zone 16 kilometres wide. In return, the United States gave Panama an initial payment of 10 million U.S. dollars, plus 250,000 U.S. dollars a year, beginning in 1913. The United States also guaranteed Panama's independence. The United States took over the French property in May 1904.

**Victory over disease.** The greatest obstacle to building the Panama Canal was disease. The Isthmus of Panama was one of the most disease-ridden areas in the world. In 1904, Colonel William C. Gorgas took charge of improving sanitary conditions in the Canal Zone. Gorgas, an American doctor, had become famous for wiping out yellow fever in Havana, Cuba, after the Spanish-American War.

Gorgas began a campaign to destroy the types of mosquitoes that carried malaria and yellow fever. The first two years of canal building were devoted largely to clearing brush, draining swamps, and cutting out large areas of grass where the mosquitoes swarmed.

By 1906, Gorgas had wiped out yellow fever and eliminated the rats that carried bubonic plague in the Canal Zone. By 1913, he had also reduced the rate of deaths caused by malaria.

**Cutting through the isthmus.** U.S. President Theodore Roosevelt appointed a civilian commission to lead the canal project. In 1906, the U.S. Congress decided to build a canal with locks, rather than the sea-level canal that the French had originally planned. Engineers believed that a canal with locks would be cheaper and faster to build. They also felt that a canal with locks would control the floodwaters of the Chagres River better than a sea-level canal would. The work progressed slowly, chiefly because of disagreements among the commission members. In 1907, President Roosevelt put Colonel George W. Goethals, an Army engineer, in charge of the project and the Canal Zone.

The construction task involved three major engineering projects. The builders had to excavate the Gaillard Cut, build a dam across the Chagres River to create Gatun Lake, and construct the canal's locks. The biggest job was digging the Gaillard Cut. The hills through which the cut runs consist of a soft volcanic material, and digging into them was much like digging into a pile of grain. As soon as workers dug a hole, more rock and earth would slide into the space, or push up from below. The engineers had estimated they would remove about 73 million cubic metres of earth and rock to build the canal. They actually dug out about 161 million cubic metres. Some of this was used later in the construction of Gatun Dam.

At the height of the work in 1913, more than 43,400 people worked on the Panama Canal. Three-fourths of the labourers were blacks from the British West Indies. Other workers came from Italy and Spain. Most of the clerical and skilled workers came from the United States.

**The oceans united.** The main work of building the Panama Canal was completed in 1914. On August 15, 1914, a passenger-cargo ship owned by the Panama Railroad Company, the S.S. *Ancon,* made the first complete trip through the canal. The ship sailed from the Atlantic to the Pacific and made a reality of the canal slogan—"The Land Divided, the World United." A giant landslide in the Gaillard Cut closed the canal for several months in 1915 and 1916. It was the last major interruption in the operation of the Panama Canal. U.S. President Woodrow Wilson proclaimed the official opening of the Panama Canal on July 12, 1920.

The canal cost the United States about 380 million U.S. dollars. This included the 40 million U.S. dollars paid to the French company, the 10 million dollars paid to Panama, and 20 million dollars for sanitation. The remaining 310 million dollars was spent on the actual construction work.

**The canal since 1920.** The Madden Dam, completed in 1935, was the first major improvement on the canal. The dam lies across the Chagres River, east of the canal. It created the 57-square-kilometre Madden Lake, which stores water for use in Gatun Lake. The dam also holds back the floodwaters of the Chagres River during the rainy season.

In 1936, the United States agreed to raise its annual payments to Panama to 430,000 U.S. dollars, which made up for a devaluation of the dollar. In 1955, the payments were increased to about 2 million U.S. dollars a year.

During the 1950's, engineers began to widen the Gaillard Cut from about 90 to 150 metres. This project was completed in 1970.

From the 1920's to the 1970's, the United States and Panama had many disputes concerning U.S. control over the Panama Canal Zone. The Panamanians regarded the zone as part of their country. They believed the 1903 treaty, which established the zone, was unfairly favourable to the United States. Some Panamanians also resented the large number of U.S. military bases in the zone. See **Panama Canal Zone.**

In 1971, Panama and the United States began negotiations for a new treaty to replace the 1903 pact. In 1977, the two nations signed two new treaties. One treaty provided for the transfer of territorial jurisdiction over the zone to Panama in 1979. This treaty also provided for Panama to take control of canal operations on Dec. 31, 1999. The other agreement gave the United States the right to defend the canal's neutrality.

Many Americans opposed giving up control of the canal and the zone, which they regarded as United States property. Other Americans favoured the treaties. They believed continued U.S. control would harm relations with Latin-American nations. The two agreements were approved by Panama's voters in 1977 and by the U.S. Senate in 1978. The treaties took effect in 1979.

In 1986, the United States, Japan, and Panama undertook a study of proposals for widening the canal or building a new sea-level canal. A sea-level waterway would not require locks. Many ships cannot pass through the lock system. In 1992, workers again began widening the Gaillard Cut. The cut with the locks is not wide enough for two-way traffic. The work was expected to take about 20 years.

**Related articles** in ***World Book*** include:

Canal
Chagres River
Clayton-Bulwer Treaty
Gatun Lake
Goethals, George W.
Hay-Pauncefote Treaty
Latin America (pictures)
Panama
Panama Canal Zone
Roosevelt, Theodore

**Outline**

**I. A trip through the canal**
**II. Importance of the canal**
**III. Administration and defence**
**IV. History**

**Questions**

What limits the size of ships that can use the Panama Canal?
Why is the Panama Canal important?
Who operates the Panama Canal?
What were the three major engineering jobs necessary to dig the canal?
What was the greatest obstacle to building the canal?
How did the Spanish-American War affect the canal?
How long does it take a ship to pass through the Panama Canal?
How was Gatun Lake formed?
What was the first major improvement on the Panama Canal?

**Panama Canal Commission.** See **Panama Canal** (Administration and defence).

**Panama Canal Zone** was a strip of land across the Isthmus of Panama that was governed by the United States from 1903 to 1979. The Panama Canal, a waterway that connects the Atlantic Ocean and the Pacific Ocean, cut through the centre of the zone. The zone came under Panama's control as a result of a treaty with the United States that went into effect in 1979.

The Panama Canal Zone was established in 1903 by a treaty between the United States and Panama. The pact gave the United States permanent control of a zone of land 16 kilometres wide and about 64 kilometres long. This grant was made for the construction and operation of the proposed Panama Canal, which the United States completed in 1914. The area designated by the treaty excluded what are now Panama City and Colón.

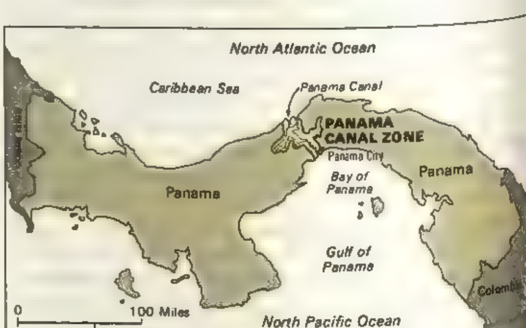
Later agreements between Panama and the United States added Madden Lake and Trinidad Bay to the area under U.S. control. Before Panama took control, the zone covered 1,676 square kilometres, including 712 square kilometres of water. The zone had a population of about 40,000, of whom about 36,000 were U.S. citizens. Most of the people worked for the U.S. Army, the Canal Zone government, or the Panama Canal Company, a U.S. government corporation that operated the canal. The U.S. citizens were called *Zonians.*

The United States and Panama had many disputes over U.S. control of the Panama Canal Zone. The Panamanians considered the zone part of their country. Crowds of Panamanians rioted in 1958 and 1959, demanding the right to fly their country's flag in the zone. In 1962, Panama and the United States agreed to fly the flags of both countries side by side in selected civilian areas of the zone. The United States also granted higher wages to Panamanians in the zone. Previously, Panamanians were paid less than Americans for the same work.

Riots broke out again in 1964, and 20 Panamanians and 4 Americans were killed. Panama then cut off diplomatic relations with the United States. Relations between the two nations were restored after the United States agreed to negotiate a new treaty to replace the 1903 pact. During the following years, three treaties were drafted. However, neither government approved any of those pacts.

During the 1970's, the two nations again held negotiations for a new treaty. In 1977, they signed two new treaties. One provided for Panama to assume territorial jurisdiction over the zone in 1979. It also provided for Panama to assume control over the operations of the canal and its associated military installations on Dec. 31, 1999. The other treaty gave the United States the right to defend the canal's neutrality. The agreements were approved by Panama's voters in 1977 and by the United States Senate in 1978. Both treaties went into effect in 1979.

See also **Panama Canal.**




**Location of the Panama Canal Zone**

**Panama City** (pop. 389,172) is the capital and largest city of Panama, a country in Central America. It lies at the Pacific Ocean end of the Panama Canal. For location, see Panama (map). Panama City is a crossroads of world trade and the centre of the nation's government. About 40 per cent of the nation's people live in the Panama City metropolitan area. The city's population has almost doubled since 1960.

Panama City consists of several widely different sections. A historic section occupies a peninsula on the Pacific coast. Old buildings line the narrow streets of this section. The Spaniards built it in the late 1600's to replace the original city, which was destroyed by buccaneers. Ruins of the original city lie near Herrera Plaza in another section, which is about 8 kilometres east of the peninsula. Zones of luxurious homes and tall, modern buildings are located near the outskirts of Panama City and in the suburbs. Other sections of the city are slums.

A number of treelined boulevards run through Panama City. The city has beautiful parks, and wide walkways extend along the seafront. Interesting buildings include the Palace of Justice, the Presidential Palace, and the ruins of the Cathedral Tower.

Most of Panama City's people have jobs related to government, trade, or the Panama Canal. Other workers provide goods and services for the many visitors involved in international trade. Factories manufacture clothing, furniture, processed foods, and other products. The Pan American Highway links Panama City with most of the rest of Panama, the Central American countries to the north, Mexico, and the United States.

Panama City was founded in 1519 by Pedro Arias de Ávila, a Spanish adventurer. Buccaneers led by the English pirate Sir Henry Morgan destroyed the city in 1671, but it was rebuilt two years later. Panama City's location on one of the main international trade routes made it a major port. After the Panama Canal opened in 1914, the city became a centre of world trade.

See also **Panama** (picture).

**Panama hat.** See **Ecuador** (picture); **Panama** (Clothing).

**Panay.** See **Philippines** (The main islands).

**Pancake Day** is the name given to Shrove Tuesday in Britain. It falls the day before Ash Wednesday, when Lent begins. *Pancake Day* gets its name from the custom of using up the household's fat and eggs to make pancakes before the Lenten fasting time. The custom of tossing pancakes on Shrove Tuesday is still observed in many parts of Britain. See also **Shrove Tuesday.**

**Pancasila** are the five principles of the Indonesian state philosophy. The five *sila* (principles) are: (1) Belief in the one supreme God. (2) Just and civilized humanity. (3) The unity of Indonesia. (4) Democracy led by the wisdom of deliberations among representatives. (5) Social justice for all the people of Indonesia.

The five principles were first set forth in a speech by Sukarno, the Indonesian nationalist leader, on June 1, 1945. Japanese occupation of Indonesia was coming to an end, and Sukarno stressed that the five principles should underlie the future independent Indonesian nation.

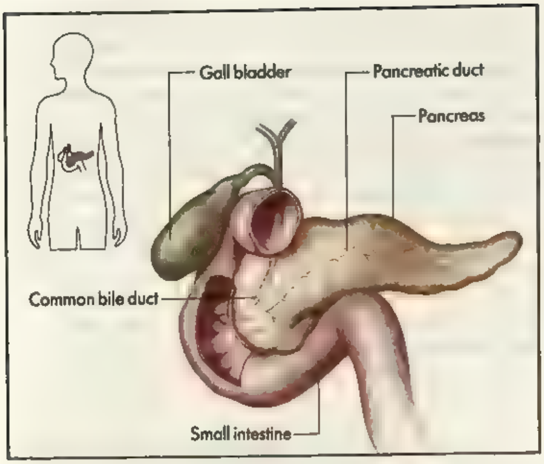
The five principles were incorporated into Indonesia's 1945 constitution. Today, they still provide the ideological basis of the Indonesian state, although their order has been slightly changed.

**Pancreas** is a body organ found in human beings and all animals with backbones. It produces digestive juices required to break down foodstuffs. It also produces *insulin* and *glucagon*, two hormones needed to regulate sugar balance and *metabolism* (see **Metabolism**).

The human pancreas is a pinkish-yellow gland about 15 to 20 centimetres long, 3.8 centimetres wide, and 2.5 centimetres thick. It lies crosswise, behind the stomach. The first part of the small intestine, the *duodenum*, loops around the pancreas. Digestive juices secreted by the pancreas flow through a duct into the duodenum. The secretion has water and salts that aid digestion and neutralize stomach acids. Enzymes in the secretion help break down proteins, starches, and fats.

Small clusters of special cells called the *islets* (or *islands*) *of Langerhans* are scattered throughout the pancreas. The cells secrete hormones directly into the bloodstream. There are several types of islet cells, including *alpha cells* and *beta cells*. Insulin is produced by beta cells. Insulin travels through the bloodstream to cells throughout the body. It enables cells to take in and use glucose from the blood. Glucose, a sugar, is the main fuel of the body's cells. If the pancreas secretes too


**A pancake race** takes place every year in some towns and villages in Britain to observe Shrove Tuesday. The women of the town compete, tossing pancakes as they run.




**The pancreas** produces digestive juice, which flows through the pancreatic duct into the small intestine. It also secretes the hormones insulin and glucagon into the bloodstream.

little insulin, a serious form of the disease diabetes mellitus results (see **Diabetes** [Diabetes mellitus]).

The alpha cells of the pancreas secrete glucagon. Glucagon causes the liver to release stored glucose into the bloodstream. Glucagon and insulin work together to regulate the level of glucose in the blood.

**Related articles** in *World Book.* See the Trans-Vision three-dimensional picture with **Human body.** See also:

Diabetes
Digestive system
Drug (picture: Some sources of drugs)
Insulin
Pancreatin

**Pancreatin** is an extract of tissue from the pancreas gland, containing digestive enzymes. Prepared as a cream-coloured powder, it is used as a medicine. Pancreatin is obtained from the fresh pancreas of pigs and cattle. Doctors sometimes prescribe pancreatin to people with stomach disorders that involve the stopping of the hydrochloric-acid flow. They also prescribe it to relieve some intestinal disorders, and to aid in the digestion of milk and some other foods.

Pancreatin contains three chief enzymes. (1) *Pancreatic amylase,* or *amylopsin,* digests starch into sugar. (2) *Pancreatic lipase* changes fats into the chemical glycerol and fatty acids. (3) *Trypsin* digests proteins into amino acids.

**Panda** is the name of two kinds of Asian animals. They are quite unlike each other in appearance. The *giant panda* is a large, black-and-white animal. The *red panda,* also called the *lesser panda,* is reddish-brown and much smaller. Both kinds live in bamboo forests on upper mountain slopes of western and southwestern China. The red panda also lives in Nepal, northern India, and northern Burma. Giant pandas are rare and are protected by law in China. The Worldwide Fund for Nature (previously the World Wildlife Fund), an international organization for the protection of wildlife, has adopted the giant panada as its symbol.

Zoologists classify the red panda as a member of the raccoon family. They disagree, however, about whether to place the giant panda in the raccoon family, in the bear family, or in a family of its own. Giant pandas have certain characteristics in common with raccoons. These include fur markings and the ability to grasp objects with the front paws. But giant pandas resemble bears in size, body shape, and general appearance. Also like bears, giant pandas can stand erect on their hind legs. Research during the 1980's has indicated that the giant panda's *chromosomes* (gene-carrying structures in cells) are chemically more similar to those of bears than to those of raccoons. As a result, most zoologists now consider the giant panda to be a bear.

**The giant panda** has a white, chubby body with black legs and a broad band of black across the shoulders. It has a large, round head; small, black ears; and a white face with black patches around each eye. This panda grows to between about 1 and 1.5 metres long and has a short tail. Adults weigh up to 160 kilograms. The female gives birth once a year to one or two cubs. Panda cubs are extremely tiny, weighing only about 140 grams at birth.

Both giant pandas and red pandas can grasp objects between their fingers and a so-called "extra thumb." This thumb, which is a bone covered by a fleshy pad, grows

**The giant panda,** *above,* is a black-and-white animal that weighs up to 160 kilograms. It often eats sitting upright with its hind legs stretched out. A red panda, *below,* weighs only from about 3 to 6 kilograms.

from the wrist of each forepaw. Pandas use their true thumbs in the same way as their fingers. The "extra thumb" of the red panda is not so fully developed as that of the giant panda.

A giant panda eats chiefly bamboo shoots, though it also eats some other plants and occasionally feeds on fish and small rodents. Two species of bamboo make up most of the animal's diet. About every 100 years, all the plants of these two species produce seeds and then die. This event occurred most recently in the late 1970's. It takes several years for the seeds to grow into plants that can provide food for pandas. By 1980, Chinese scientists reported that at least a quarter of the giant-panda population had starved to death.

**The red panda** has long, soft fur, and a bushy tail with rings like that of a raccoon. This panda is much smaller than the giant panda. It weighs from about 3 to 5 kilograms and grows about 60 centimetres long, not including the tail. It has reddish-brown fur and a pale face with a rusty-red streak that curves downward from each eye.

Like the giant panda, the red panda feeds on bamboo shoots. It also eats acorns and roots, and sometimes fish, insects, and mice. The red panda easily climbs trees, where it sleeps most of the day. It searches for food at dawn and dusk.

**Giant pandas in zoos.** In 1972, China gave two giant pandas to the United States following U.S. President Richard M. Nixon's trip to China. These two pandas—Ling-Ling, a female; and Hsing-Hsing, a male—were kept in the National Zoological Park in Washington, D.C. The London Zoo also received two pandas, Chia-Chia and Ching-Ching, from China in 1974. The Chinese government has loaned pandas to various other European and U.S. zoos.

Most attempts to breed giant pandas in zoos outside China have failed. Ling-Ling gave birth to cubs in 1983, 1984, and 1987. However, each of the cubs died within a few days after birth.

**Scientific classification.** Most zoologists place the giant panda in the bear family, Ursidae, and classify it as *Ailuropoda melanoleuca.* However, some zoologists place it in the raccoon family, Procyonidae, and others classify it in a family of its own. The red panda belongs to the raccoon family. It is *Ailurus fulgens.*

See also **Raccoon.**

**Pandemic.** See Epidemic.

**Pandit, Vijayalakshmi** (1900-1990), one of India's most famous women, was distinguished for her work in government and for her interest in the women's movement. Madame Pandit was appointed ambassador to the Soviet Union in 1947 and ambassador to the United States in 1949. From 1953 to 1954, she served as the first woman president of the United Nations General Assembly. She then became Indian high commissioner in Britain. She became ambassador to Ireland in 1955 and ambassador to Spain in 1958, and held both posts until 1961. She was governor of the Indian state of Maharashtra from 1962 to 1964, and served in India's Parliament from 1964 to 1967. She retired from public life in 1968.

**Vijayalakshmi Pandit**

Madame Pandit was born in Allahabad, India. Like her father and brother, Motilal and Jawaharlal Nehru, she took a prominent part in India's struggle for independence and was jailed several times. Her brother served as India's prime minister from 1947 to 1964. Indira P. Gandhi—her niece and Jawaharlal's daughter—became prime minister of India in 1966. In 1977, Madame Pandit campaigned against her niece's political party, Congress, because she opposed the way it had restricted freedom in India.

See also **Nehru** (family); **Gandhi, Indira; India, History of.**

**Pandora,** in Greek mythology, was the first woman. Zeus, the king of the gods, ordered the creation of Pandora as a punishment for men. He was angry because men had received fire stolen from the gods by Prometheus (see **Prometheus**). Zeus ordered Hephaestus, the blacksmith of the gods, to create Pandora. The gods and goddesses then adorned Pandora with gifts to make her appear alluring. The name *Pandora* means *all gifts* in Greek.

Zeus gave Pandora to Prometheus' brother Epimetheus. In spite of Prometheus' warnings, Epimetheus gave her to men. Pandora's curiosity led her to open a jar, and all types of evil, including disease and hard labour, escaped to plague humanity. Only Hope did not escape from the jar. Ancient Greek sources are vague about the origin of the jar.

Many writers have noted the resemblance between Pandora and Eve in the Bible. In 1508, the Dutch author Desiderius Erasmus first used the image "Pandora's box" instead of the traditional jar or vase. Pandora's box has come to symbolize any object or situation that has a great potential for evil.

**Pangaea.** See **Earth** (The shaping of the continents).

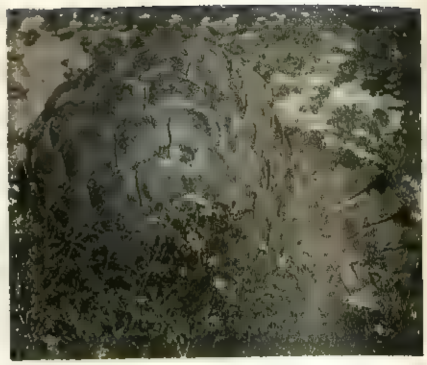
**Pangolin** is the name of several species of animals that resemble anteaters and armadillos. Pangolins live in southeastern Asia, Indonesia, and parts of Africa south of the Sahara. Like anteaters, pangolins are toothless and have long, narrow snouts, long tails, and sticky, ropelike tongues that they can thrust far out to catch the ants on which they feed. Pangolins have coats of mail formed by overlapping horny scales, instead of the coarse hair of anteaters. These scales are various shades of brown.

Pangolins vary in length from 0.9 to 1.5 metres, depending on the species. The *long-tailed pangolin* of western Africa lives in trees. Its tail is about two-thirds of its total length. All pangolins have large, strong claws on their forefeet, which they use to rip open the nests of ants and termites.

Pangolins can roll themselves into tight balls so heavily armoured that few enemies can harm them. They are inoffensive animals, but when captured they may lash out with their scaled tails.

Pangolins are much hunted for their excellent meat. But because they are shy and look for food only at night, they have been saved from extinction.

**Scientific classification.** Pangolins make up the family Manidae. Asian pangolins make up the genus *Manis.* African



**Pangolins** live in southeastern Asia, Indonesia, and parts of Africa. The animal has a coat of horny scales. It rolls itself into a ball, *right,* for protection against attackers.

pangolins make up the genus *Phataginus.* The scientific name for the long-tailed pangolin is *Phataginus tetradactyla.*

See also **Anteater.**

**Panini** was a grammarian of the ancient, Indian language of Sanskrit. Scholars are uncertain about the details of his life. He was probably born in the Punjab in 500's or 600's B.C.

His *Ashtadhyayi* grammar is without equal in the history of language. Scholars regard it as a masterpiece of analysis. In ancient India, grammar was not simply an academic subject. It formed part of the *Vedas,* the sacred texts which are the foundation of Hinduism. The *Vedas* were originally recited from memory rather than written down. It was important that they should be recited absolutely correctly and without any changes to the words or their pronunciation, because they were sacred. But languages tend to change over the years. Panini worked to provide a set of rules to stop Sanskrit from being corrupted. Future generations of writers followed his rules. Sanskrit literature, which includes drama and poetry, as well as religious texts, continued to be written in this classical style for hundreds of years.

**Panipat, Battles of,** took place around Panipat, which is now an Indian town and district in the state of Haryana. It stands in an open plain on the Jumna (Yamuna) River, about 80 kilometres north of Delhi. Its position controls access to Delhi and, as a result, it has been the site of several important battles.

The Sultan of Delhi, Ibrahim Lodi, was killed at Panipat in 1526 during a battle with the forces of the Mughal emperor Babar. This defeat ended the Delhi Sultanate and laid the foundation of the Mughal Empire (see **Mughal Empire**).

In 1556, the forces of Babar's grandson, Akbar, defeated the army of the general Hemu, in what is usually called the second battle of Panipat. This defeat helped to end threats to the power of the Mughal Empire.

The third battle of Panipat took place in 1761. In this battle, Afghan armies under the command of Ahmad Shah Durrani defeated Maratha forces that had threatened the Mughals.

**Pankhurst, Emmeline Goulden** (1858-1928), led the fight for women's voting rights in England. With her husband, Richard M. Pankhurst, she helped form the Women's Franchise League in 1889. In 1903, she helped organize the National Women's Social and Political Union, with the slogan "Votes for Women." In their bold programme, Mrs. Pankhurst's followers differed from older "suffragettes." They staged parades and engaged in such violence as window-breaking to gain attention. She and her followers, including her daughters Christabel and Sylvia, suffered rough handling and imprisonment. During World War I (1914-1918), they turned to patriotic work.

Women received equal voting privileges in England the year of Mrs. Pankhurst's death. She was born in Manchester, England.

**Panmunjom** is the site of the truce talks that ended the Korean War in 1953. It lies in a neutral area, called the *Demilitarized Zone,* between North Korea and South Korea (see **Korea** [map]).

Before the truce talks, Panmunjom was a small civilian village. Today, it is the point of contact between North and South Korea, and between United States and North Korean military representatives. The Panmunjom area is guarded by North Korean forces on the north side, and South Korean and U.S. troops on the south side. A number of buildings that house offices and guard units stand in and near Panmunjom.

The Korean War truce talks took place between the United Nations Command—represented by the United States—on one side, and North Korea and China on the other side. The talks began in July 1951 in Kaesong, a city under North Korean control. In October, the talks were moved to Panmunjom, situated in neutral territory. The talks led to the signing of a truce agreement on July 27, 1953.

See also **Korean War.**

**Pansy** is a commonly cultivated type of violet. The beautiful flowers may be purple, violet, blue, yellow, white, brown, deep red, or a mixture of these colours. The pansy is a low-growing plant that grows best in a moist location with some shade. The common garden pansy is a *hybrid* (a cross between two species). Most garden varieties live only a year. Some varieties are *perennials*—that is, they live for at least three years. The word *pansy* comes from the French word *pensée,* which means *thought.*

The pansy is also called the *heartsease, ladies-delight,* and *stepmother's flower.* The *European wild pansy,* also known as the *field pansy,* is a perennial with much smaller flowers.

**Pansies** belong to the violet family. Their velvety flowers occur in a variety of colours or combinations of colours. Pansies grow best in moist areas that have some shade.

**Scientific classification.** The pansy belongs to the violet family, Violaceae. The common garden pansy is *Viola X wittrockiana.* The field pansy is *V. arvensis.*

See also **Flower** (picture: Garden annuals).

**Pantheism** is the belief that the essence of God is in all things. It is often associated with nature religions, including many American Indian, African, and ancient Middle Eastern religions. In these religions, gods are connected with such things as storms, stars, the sky, the sea, fertility, and skill in hunting. In the Japanese Shinto tradition, gods are identified with natural objects, including rocks and trees. In a more general sense, pantheism refers to any religious philosophy that identifies God with nature.

See also **God; Polytheism.**

**Panthéon.** See **Paris** (Famous buildings).

**Pantheon** is a well-preserved ancient temple in the centre of Rome. The Pantheon was completed under the rule of the Roman emperor Hadrian about A.D. 126. Hadrian dedicated the temple to all the Roman gods. Its name comes from the Greek word *pantheion,* which means *place for all gods.* The temple served as a Christian church from 609 until 1885. It then became a national shrine and the burial place for Italian national heroes. Famous Italians buried there include King Victor Emmanuel I and the Renaissance painter Raphael.

The Pantheon was constructed largely of brick and concrete. It is a circular building that measures about 43 metres in diameter. It has a dome roof that rises about 43 metres above the floor at its highest point. A rectangular *portico* (porch) extends from the entrance of the building. The portico has a triangular roof that is supported by a row of eight Corinthian columns. Many of the engineering techniques used to build the Pantheon are still used today.

The Pantheon was one of the first buildings to emphasize interior space rather than exterior form. The interior is beautifully and evenly lit by an *oculus* (opening) that measures 9 metres in diameter at the top of the dome. The proportions of the central space have been praised for their harmony. The bronze doors at the entrance and some of the marble used in the interior decoration are part of the original construction of the Pantheon.

See also **Dome** (picture); **Architecture** (Roman architecture).

**Panther** is a name used loosely for certain members of the cat family. It is especially given to the black form of the *leopard,* which is a native of Asia and Africa. The *puma* of North America, also known as the *cougar* or *mountain lion,* is sometimes called a panther, particularly in the eastern United States. A few authorities apply the name only to large leopards. See also **Leopard.**

**Pantograph** is the name of a mechanical drawing instrument which copies, traces, or cuts in duplicate a design, map outline, or drawing. It is made of four bars or rods held together by adjustable pins. One end of the pantograph is held stationary. One tracing point is moved over the design to be copied, following its outline. Another point will then move in unison, copying or cutting a duplicate outline. The pantograph can be set, by using adjustable pins, to copy to any size.

**Pantomime,** in the British Isles, is a traditional Christmas entertainment. Basically, the Christmas pantomime tells a story, usually a fairy tale, such as *Cinderella,* or a nursery rhyme, such as *Humpty Dumpty.* Sometimes the *slapstick* comedy parts are unspoken, but most of the rest of the story is told as in a play or musical comedy. But pantomime also includes dancing, singing, and specialtity acts such as juggling.

Pantomime developed out of traditions that date from the Middle Ages. In the *commedia dell' arte* of Italy, the two most important figures were Harlequin, a servant, and Columbine, the daughter of Harlequin's master, Pantaloon. Harlequin was assisted by Puncinello, a clown. *Harlequinades* (entertainments in which these characters appeared) became popular in the 1700's. In 1717, John Rich, a theatre owner, dancer, and mime, produced *Harlequin Sorcerer* at the Lincoln's Inn Fields Theatre. Rich introduced spectacular devices into the harlequinade.

The next important figure was Joseph Grimaldi, the greatest of clowns. His jokes, songs, and personality made the Clown the main figure in pantomime. See **Grimaldi, Joseph.**

In the late 1800's, fairy tales became the basis of most

**A pantograph** is a mechanical drawing instrument that allows an artist to duplicate a design with speed and accuracy.

pantomimes. Harlequin and the Clown were only secondary characters. A custom grew up by which an actress played the *principal boy* (hero). The gusto of the music-hall comedians superseded the more subtle humour of the Clown. Dan Leno became famous for his playing of pantomime *dames* (comic female characters). The harlequinade survived only in some provincial theatres and at the Lyceum Theatre, in London. See **Leno, Dan; Music hall.**

By the end of the 1800's, pantomime was taking its present form, mainly as the result of the work of Augustus Harris at the Drury Lane Theatre, in London. It became a Christmas entertainment.

In some parts of the world, the word pantomime refers to the form of acting usually called mime. See **Mime.**

**Pantothenic acid.** See **Vitamin** (Vitamin B complex).

**Papacy.** See **Pope; Roman Catholic Church.**

**Papal infallibility.** See **Vatican Council I; Pope** (The powers of the pope).

**Papal States** was the name given to territory once ruled by the pope of the Roman Catholic Church. The pope exercised *temporal* (economic, military, and political) control over the Papal States. Most of the states were located in central Italy, with some lands in France for a time. Today, the pope has temporal control only over the 44 hectares of Vatican City, an independent state within the boundaries of Rome.

The Papal States originated in 756 with land that Pepin the Short, king of the Franks, gave to Pope Stephen II. The Papal States began to grow during the reign of Saint Leo IX in the mid-1000's. The states expanded the most in the 1200's, particularly under the leadership of Pope Innocent III. The Papal States declined in political and economic strength during the 1600's and 1700's.

In 1809, Emperor Napoleon I of France annexed the Papal States and made Pope Pius VII a prisoner. After Napoleon's defeat, the Congress of Vienna restored most of the states to the pope in 1815. However, the return was temporary. Residents of the Papal States revolted against papal control in 1831, in 1848 and 1849, and again in 1860. During the revolt of 1860, Victor Emmanuel II conquered central Italy, and in 1861 he declared the formation of the Kingdom of Italy. Victor Emmanuel became its first king. Only the land immediately surrounding Rome remained under the control of the church. The establishment of the Kingdom of Italy began a period of political and religious conflict between the popes and the Italian government, known as the Roman Question.

In 1870, French forces stationed in Rome withdrew, and Victor Emmanuel captured the city. He asked Roman citizens whether the city should become the political capital of a united Italy. The people voted for unification, thus effectively ending the Papal States as a dis-

**Pantomimes** are a traditional form of entertainment at Christmastime. The fairy-tale story of *Cinderella* is a popular story for many pantomimes produced each year, *above* and *left*.


**The Papal States before 1870** were large and important tracts of land in the heart of Italy. Today, the Holy See has temporal power only over Vatican City in Rome.

tinct church-controlled territory. Pope Pius IX shut himself up in the Vatican in protest and referred to himself as a prisoner.

The Roman Question was finally resolved in 1929. In that year, an independent Vatican City state was established through an agreement called the Lateran Treaty. The treaty was made between Pope Pius XI and the Italian government. Under its terms, all financial claims between the two sides were settled, with Italy presenting a payment of cash and bonds to the church. The papacy, in effect, gave up its claims to the territory of the Papal States. Vatican City was to be fully independent. The church was to have exclusive jurisdiction within its boundaries, and the territory was always to be considered neutral and inviolable. The Italian government accepted both the church's status as the official state religion and the church's jurisdiction in Italy over such matters as marriage and divorce.

In 1985, the Italian government and the Vatican ratified a revised version of the Lateran Treaty. The revised treaty retained the independence of Vatican City but ended other church privileges, including the church's status as the state-supported religion in Italy.

See also **Italy** (History); **Vatican City; Rome** (History); **Pepin the Short.**

**Papaw.** See **Papaya; Pawpaw.**

**Papaya** is a tropical fruit that has edible flesh and seeds. Papayas have a slightly sweet taste, and they are rich in vitamins A and C. People usually eat the fruits fresh for breakfast or for dessert. The ripe fruit is also used in jellies, juices, pies, salads, sauces, and sherbets. Unripe papayas are boiled or baked like vegetable marrow. In addition, green, immature papayas are the source of *papain,* an enzyme used as an aid to digestion and as a meat tenderizer. This enzyme is obtained by drying the sticky, white milk the fruits yield when their skin is scratched.

Papayas vary in shape from round to oval. In most cases, the ripe fruit weighs from 0.1 to 7 kilograms and has smooth skin that ranges in colour from greenish-yellow to orange. The flesh may be yellow, orange, or red, and it is filled with the fruit's pea-sized black seeds.

**Papaya** is a tropical fruit that grows on a palmlike tree. Papayas have a mild, sweet flavour and are rich in vitamins A and C. They are usually eaten fresh for breakfast or dessert.

Papayas grow on slender, palmlike plants that may reach a height of over 10 metres. The plants grow best in fertile, well-drained soil. They develop quickly from seeds and begin to bear fruit 9 to 12 months after planting. Their annual yield varies greatly, from as few as 12 fruits to as many as 150.

The papaya is native to the region in and around Central America. The fruit is grown commercially in many tropical areas. Brazil, Chile, Indonesia, India, and Mexico are the world's leading producers.

In New Zealand and some other English-speaking countries, papayas are also called *pawpaws.* However, papayas are not the same as the pawpaw fruit of the southern United States (see **Pawpaw**).

**Scientific classification.** The papaya belongs to the family Caricaceae. It is *Carica papaya.*

**Papeete.** See **Society Islands; Tahiti.**

**Papen, Franz von** (1879-1969), was a German politician who helped make Adolf Hitler head of the German government in 1933. Papen persuaded Paul von Hindenburg, Germany's president, to appoint Hitler *chancellor* (prime minister). Papen did not belong to Hitler's Nazi Party, which had become Germany's largest political force by 1933. Papen, who had been forced to resign as chancellor in 1932, wanted to use the Nazis to stabilize Germany's government. But he hoped that he and his fellow conservatives would keep the real power. However, Hitler quickly made himself dictator.

Papen was born in Werl, near Dortmund, Germany, to an aristocratic family. He gained political power through friendship with Hindenburg. When Hitler took power, Papen became vice chancellor. Papen served as Germany's special minister and ambassador to Austria from 1934 to 1938 and as its ambassador to Turkey from 1939 to 1944. In Turkey, he organized Nazi spy operations during World War II (1939-1945). In 1946, Papen was found innocent of war crimes at trials held in Nuremberg, Germany, by the nations that defeated Germany in the war. But German courts imprisoned him until 1949.

**Paper** is one of the world's most important industrial products. Books, magazines, and newspapers are printed on paper. Data obtained from computers are usually printed on paper. Education, government, and industry could not operate without printing and writing papers. Other important paper products include cardboard, which is used in packaging, and absorbent papers, such as tissue and towelling.

The United States is the world's leading producer of paper. Nearly 70 million metric tons of paper and cardboard are produced in the United States annually.

Paper is made from cellulose fibres, which are found in all plant cell walls. When a mixture of water and fibres is filtered through a fine screen, the fibres tangle together to form a sheet of paper. As the wet sheet is dried, chemical bonds form between the molecules in the cellulose fibres, giving the sheet of paper its strength. Papermaking fibres come from many different plant sources, including bamboo, cotton, esparto grass, hemp, jute, sugar cane, wheat and rice straws, and various woods. Wood is the major source of papermaking fibres.

Paper manufacturers produce thousands of grades and types of paper. The properties of any paper depend on the fibres and processes used in making it.

## How paper is made

**Raw materials.** For centuries, the principal raw materials used in papermaking were cotton and linen fibres obtained from rags. Today, these fibres have been largely replaced by wood *pulp.* Pulp is the name used for fibres that have been prepared for papermaking. Wood used for papermaking is either harvested for the sole purpose of making paper or it comes from timber and woodworking wastes. Some cotton and linen fibres are still used for high-quality writing papers, business letterhead papers, art papers, and documents that will be kept for years.

Wood pulps are obtained from many kinds of wood, including aspen, beech, birch, fir, gum, hemlock, oak, pine, and spruce. The fibres used for papermaking were once living cells in the wood of the tree trunk. Fibres are thin, hollow tubes sealed at the ends, and are from 1 to 5 millimetres long. A substance called *lignin* holds the fibres together.

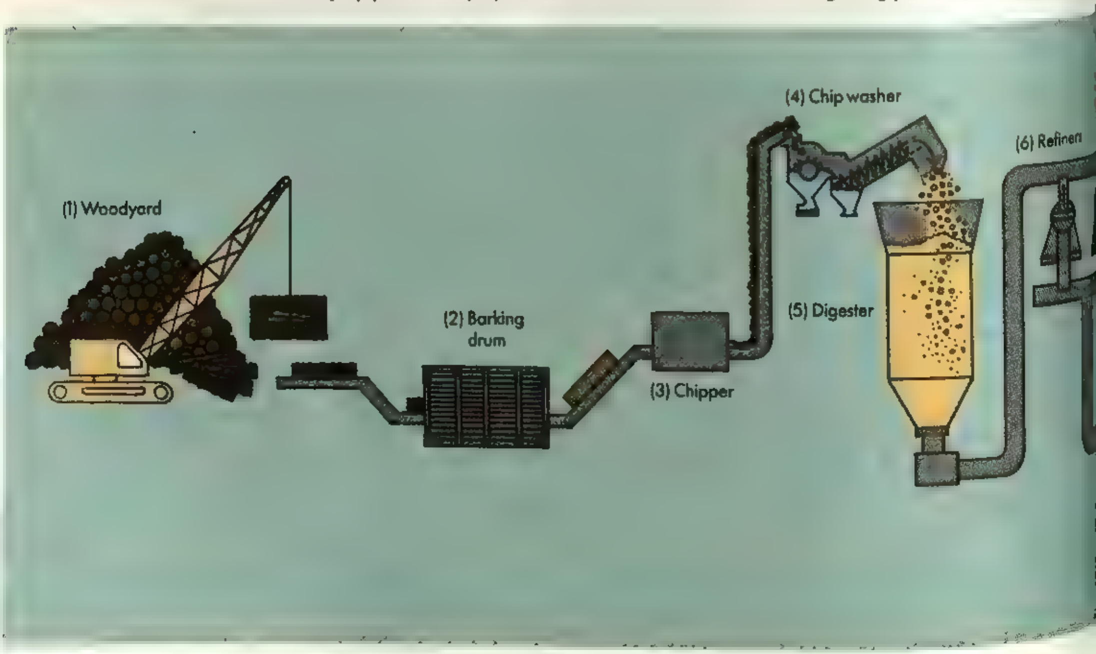
Waste paper is sometimes reused to make new paper through a process called *paper recycling.* Large tanks called *pulpers* convert newspapers, magazines, and other printed wastes into usable pulp. Ink is removed from the paper through use of solvents and other chemicals, detergents, and special cleaning methods. Recycled fibre is sometimes called *secondary fibre.* Manufacturers use secondary fibre to make cardboard, some printed papers, paper napkins, and towelling.

**Pulping processes.** There are three different kinds of pulping processes used to convert wood into pulp. They are (1) mechanical processes, (2) chemical processes, and (3) semichemical processes. Semichemical processes combine chemical and mechanical methods.

The oldest mechanical process is the *stone groundwood process,* in which short logs are forced against a specially prepared grindstone. Friction heats the wood and causes the lignin between the fibres to soften. The grindstone then can easily grind fibres from the surface

## How paper is made from wood

The diagram below illustrates the steps involved in making paper from wood. It shows the semichemical method of making wood pulp. The pulping process begins with logs from the *woodyard.* The logs are fed into a revolving *barking drum,* which removes the bark. Then they are cut into chips in a *chipper.* The chips are washed in a *chip washer* and treated in huge tanks called *digesters.* In a machine called a *refiner,* rotating discs break the pulp down into individual fibres. The refined pulp passes into *pulp washers,* where chemicals from the digesting process are rinsed off.



of the wood. In *thermo-mechanical pulping,* wood chips are preheated and fed between the rapidly rotating discs of a machine called a *refiner.* The action of the discs breaks the heated wood into individual fibres.

In chemical pulping processes, chemicals dissolve the lignin between the wood fibres. First, the wood is washed and cut into chips about 12 to 25 millimetres long. In the *sulphite chemical process,* the wood chips are cooked in an acid solution in a steam-heated pressure tank called a *digester.* In the *Kraft process,* also called the *sulphate process,* chips are cooked in a solution of caustic soda and sodium sulphide. The cooking can be done in a *batch digester* or in a large tower called a *continuous digester.*

Semichemical processes use chemicals to soften the lignin. Disc refiners then mechanically separate the fibres from one another.

Pulps produced by any of the processes are washed and then passed through a series of screens to remove knots, debris, and other foreign material. Some pulps may be bleached in order to produce a whiter sheet of paper.

**Refining.** In refining, the pulp passes between the rotating plates of a disc refiner. The mechanical action of the refiner unravels the fibre cell wall, making the fibres more flexible. The amount of refining the pulp receives determines the quality of the paper.

**Sheet formation.** At one time, all paper was made by hand, one sheet at a time. Today, a papermaking machine called the *Fourdrinier machine* can make a continuous sheet of paper up to 10 metres wide, at speeds faster than 900 metres per minute. Some Fourdrinier machines measure more than 110 metres in length.

To make the sheet, a device called the *headbox* spreads a mixture of water and fibres across the *wire,* a continuously moving screen. As the wire moves along the Fourdrinier machine, water drains off, leaving a mat

**Leading paper-manufacturing countries**


Figures are for 1989. Germany figure is for period before unification; Soviet Union figure is for period prior to the country's breakup. Source: Food and Agriculture Organization of the United Nations.

The pulp is then forced through screens that remove knots, debris, and other unwanted material. The formation of paper sheets begins in the *headbox,* where wet fibres are spread across a moving screen called a *wire.* Water drains off, leaving a mat of fibres. The mat passes between rollers that squeeze out most of the water. Steam-heated cylinders further dry it. The dried sheet is smoothed between the cylinders of a *calender stack* and fed onto a giant roll on a *paper reel.* Finally, the large roll of paper is shipped to a manufacturing plant to be made into finished products.

of fibres on the surface of the wire. Suction devices help to drain the water through the wire. When the mat is about one-fifth fibre and four-fifths water, the sheet has enough strength to be removed from the wire. The sheet then passes between large press rolls that squeeze water from the sheet until it is about one-half fibre and one-half water. Most of the remaining water is removed as the sheet passes over steam-heated cylinders. Chemical bonds that hold the finished sheet together form during this drying process.

The dried sheet may be smoothed by pressing it between the cylinders of a *calender stack*. It is then wound into giant rolls at the *reel*, and shipped to manufacturing plants to be made into finished products.

*Twin-wire machines* are similar to Fourdrinier machines, except that the sheet is formed between two moving screens. This enables the papermaker to remove water from both sides of the sheet.

A *cylinder machine* is used to make heavy paper and cardboard. A wire-covered cylinder, called a *mould*, is partially immersed and rotated in a vat of water and fibres. The sheet forms on the cylinder as water passes through the screen covering. The wet sheet is removed from the mould by a moving fabric belt called a *felt*. Several sheets of fibres can be layered on a single felt to form a multilayer cardboard. Sheets formed on cylinder machines are pressed and dried before they are wound on a reel.

### Special kinds of paper

The properties of paper depend on various factors. These factors include the type of pulp used, the amount of refining done on the pulp, and the kind of papermaking machine used. Special additives, as well as treatments given to the paper during or after its manufacture, also affect the finished product.

Newsprint is usually made from a blend of one part chemical pulp for strength and three parts groundwood pulp for low cost and good printing properties. Many writing and printing papers are *sized* to prevent inks from spreading into the paper. Sizing is done either by including a mixture of resin and alum in the sheet or by coating the surface of the sheet with a starch solution. Dyes that bind to the pulp fibres produce coloured papers. Many magazine and book papers are coated with a mixture of starch solution and clay. The coating becomes glossy when the paper is polished between the rolls of a *super-calender*. Paper treated in this way is especially good for printing.

Inexpensive writing papers are made from mechanical pulps. Higher-quality writing papers use blends of bleached chemical pulps. Rag pulps produce the finest writing papers. Many writing and document papers are *watermarked* by pressing a wire pattern into the top surface of the wet sheet while it is still on the Fourdrinier wire (see **Watermark**).

Towelling and napkins are made from recycled fibres or from blends of sulphite and mechanical pulps. Papermakers use special additives to give these products strength when wet. Most bag papers are made from well-refined, unbleached Kraft pulps. Bleached Kraft pulps are used for food packaging. Bleached Kraft cardboard may be coated with wax or plastic for milk cartons and paper cups. Cereal boxes and other cartons, tablet backs, and posterboards are made on cylinder machines from recycled newsprint.

### Other products

Pulping processes produce a number of useful byproducts. For example, used Kraft pulping chemicals can be treated to recover turpentine and *tall oil*, a raw material in paints and plastics. Imitation vanilla extract and alcohol can be made from used sulphite cooking solutions.

Some wood pulps are made for purposes other than papermaking. For example, mechanical and sulphite pulps serve as absorbent wadding in sanitary products and nappies. Manufacturers use pure sulphite pulps as raw materials for rayon and cellophane.

### History

Paper gets its name from *papyrus*, a reed that the Ancient Egyptians used for making a writing material. They cut papyrus stalks into thin strips and pressed crisscrossed layers of strips into sheets. The paper formed was white, textured, and porous.

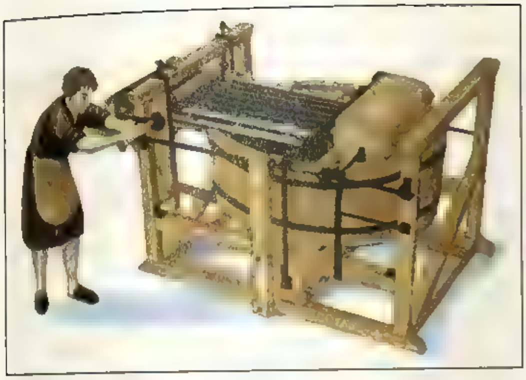
Paper as we know it was invented in China more than 2,000 years ago. At first, the Chinese used the hemp

Wall painting from Dynasty XVIII (1570-1320 B.C.)

**Paper in Ancient Egypt** was made from the fibres of a water plant called papyrus. This tomb painting shows workers harvesting and bundling papyrus.

Woodcut (1700s)

**Papermaking in Japan** involved mixing fibres and water, *left*. A worker scooped the mixture into a screenlike mould, *right*. The water drained away and the moulded fibres dried into sheets.



**A papermaking machine** was the first device that could produce paper in a continuous roll rather than in single sheets. Nicholas Louis Robert invented the machine in 1798.

plant or the inner bark of the mulberry tree for fibre. Later, they found that good papermaking fibres could be obtained by pounding rags, rope, or old fishing nets into a pulp. Early Chinese paper was too coarse for use in writing. The Chinese used it for wrapping and clothing.

The Chinese art of papermaking spread to other parts of the world after several Chinese papermakers were captured by Arabs in what is now Western Turkestan. The Arabs urged the papermakers to continue their art and teach it to the Moors in the city of Samarkand, which is now in Uzbekistan.

The paper industry was established in Baghdad around A.D. 795. Papermaking eventually spread throughout Europe as a result of the Crusades and the Moorish conquest of northern Africa and Spain.

In 1798, a Frenchman named Nicholas Louis Robert invented a machine to make paper in continuous rolls rather than sheets. The Fourdrinier brothers, who were English merchants, financed improvements to this machine in 1803. The first American Fourdrinier machine was built in 1827.

The stone groundwood method for making wood pulp was developed in Germany in 1840. In 1854, the first chemically produced wood pulp was made in England. During the 1850's, the American chemist Benjamin C. Tilghman found that the fibres in wood could be separated by treating them with sulphurous acid. By 1882, much of the wood pulp used was made by this sulphite process.

In 1883, a German inventor named Carl Dahl discovered that adding sodium sulphate to the soda process produced a very strong pulp. This discovery produced the Kraft process. *Kraft* means *strength* in German. During the early 1900's, the Kraft process became the most important pulping process, and the Fourdrinier machine became the primary device for making paper.

Significant improvements in papermaking in recent years include thermo-mechanical pulping, synthetic wires and felts, twin-wire machines, and the use of computers to control pulping and papermaking operations. Paper manufacturers have also worked toward improving pollution control and energy conservation in the industry.

**Related articles** in *World Book* include:

| | | |
|---|---|---|
| Cardboard | Ink | Papyrus |
| Cellulose | Lignin | Parchment |
| Chemurgy | Manuscript | Printing |
| Environmental pollution (diagram: Waste recycling) | Microcrystalline wax | Recycling |
| | Paper bag | Sweden (picture) |
| | Papier-mâché | Watermark |

**Paper bag** is one of our most useful items. It may vary in size from a small sweet wrapper to a huge shopping bag. Yet, about a hundred years ago, the paper bag was unknown. In the 1850's, manufacturers shipped most commodities such as flour and sugar to shopkeepers in bulk. If the customer did not bring a container, a clerk

**A modern paper roller** is one of the last steps in the paper manufacturing process. This computerized machine winds paper into large rolls before the roll is cut into sheets.

would make a *cornucopia,* or a twist from paper. As trade developed, many merchants began pasting such containers together in advance. They turned up the end to form a "package" ready for quick use. Several machines for making paper bags were invented in the United States by the early 1860's. S. E. Pettee built the best known of these machines. He began licensing his apparatus to printers in 1865. He collected a royalty for their use.

Pettee's success spurred other inventors to creative effort, but these early attempts did not create the industry. The U.S. paper bag industry was born in 1869 when the best features of all types of machinery were purchased and put together in one machine by the Union Company of Pennsylvania.

The swift success of the concerns that started paper bag manufacture caused the Union Company to go into business itself in 1875 as the Union Bag and Paper Company. In the first year it made 606 million bags. This was a fabulous number in those days, and the industry was established. The mass production greatly cut costs to retailers.

Today, manufacturers produce four main types of paper bags: The *flat bag* is a flat tube sealed at one end, such as a small sweet bag. The *square bag* has tucks at the sides to give more space. A popcorn bag is an example. The *satchel-bottom bag* has a large bottom section so that it will stand upright when filled. The *automatic bag* has a rectangle-shaped bottom and tucks in the side, so that it can be opened easily with a snap of the hand.

Speciality bags include bags with smooth linings to prevent damaging fragile items. Others may be greaseproof, mothproof, or heat-sealed.

**Paper nautilus.** See **Argonaut** (mollusc).

**Paperback book.** See **Book** (The 1800's; Modern books); **Publishing** (Designing and printing).

**Paperbarks** are large Australasian trees that have loose bark that looks like paper hanging from their

**Paperbarks** of many kinds grow in Australia. Their bark hangs from their trunks like loose paper.

trunks and branches. There are several species. They generally grow in moist situations such as along river banks and swamps. The leaves of many species yield oils that have antiseptic properties, and have a camphor-like smell. See **Camphor**. Two kinds grow both in Australia and in similar sitituations in Papua New Guinea. See also **Tree** (picture).

**Scientific classification.** Paperbarks belong to the family Myrtaceae, genus *Melaleuca.*

**Paperwork** refers to the use of decorative papers. People have designed and used such papers for hundreds of years. Most decorative papers are made with paper produced by machines. But some of the finest decorative papers are made with handmade paper. The printing of decorative papers involves the use of such graphic arts processes as wood-block and linoleum-block engraving.

Decorative papers can be divided into several categories, including end paper, lining paper, wallpaper, wrapping paper, and paper handicrafts.

**End papers** are decorative papers that printers once pasted on the inside of the front and back covers of books. The use of end papers dates back to early printed books. Most end papers were made of *marbled paper*—that is, paper printed to resemble the lined and mottled appearance of marble.

**Lining papers** are used to line drawers and to cover cupboards and shelves. They often have lively floral designs with a recurrent bird pattern. Lining papers may also be decorated with small, repeated landscapes or other scenes.

**Wallpaper** is decorative paper used to cover inside walls. People have used wallpaper for hundreds of years in such countries as England, France, and the United States. During the 1700's, artists designed wallpaper with formal landscape scenes. Such paper was made only for the wealthy. It was widely used in France and England and exported to the United States. Also during the 1700's, many people used wallpaper decorated with Chinese objects and patterns, in a style called *Chinoiserie.* See **Wallpaper.**

**Wrapping paper** is used for wrapping gifts. Many wrapping papers have attractive and colourful patterns that make them suitable for use at holidays, birthdays, or other special occasions. The most common wrapping papers are glazed papers printed on one side only. Wrapping papers also include patterned tissue paper. In addition, people wrap gifts with such paperlike materials as metal foil and tinted cellophane.

**Paper handicrafts** have been popular for centuries. Today, people frequently make paper decorations for parties and other special events. Crepe paper is widely used to make such objects as costumes, paper flowers, and holiday novelties, including Christmas tree ornaments. In the folk art called *quilling,* thin strips of paper are coiled and pinched into teardrop or eye shapes and glued together in order to make abstract designs and figures.

Both the Chinese and the Japanese have developed traditional paper handicrafts that involve making cuts in folded pieces of paper. The cuts create elaborate patterns that appear when the paper is unfolded. The Japanese also fold uncut sheets of paper to make decorative objects in an art form called *origami* (see **Origami**).

**How to make a papier-mâché doll**

**To begin the doll,** wrap a bottle with clear plastic and then tape a layer of heavy paper to the plastic, *left.* Next, tape a cone of heavy paper to the top of the bottle, *right.*

**To complete the body,** paste many layers of newspaper strips to the bottle, *left.* Then cut the doll's head out of heavy paper and attach it with tape to the cone, *right.*

**To decorate the doll,** remove the bottle, leaving the paper shell. Then paint the doll with watercolours, *left.* Finally, add a paper skirt and paste on yarn for hair, *right.*

**Papier-mâché** is a mixture of paper and glue used in crafts and the fine arts. Papier-mâché is a strong material used to make such items as furniture, jewellery, masks, dolls, and toys. Artists use papier-mâché to create sculptures.

Traditional papier-mâché involves tearing paper into small pieces and adding them to white glue or wallpaper paste until the mixture becomes pasty. The mixture can be placed into a mould or built up on a frame made of wire or other material. The frame has the skeletal shape of the object being made. Papier-mâché can also be made by tearing paper into small squares and coating each piece with glue. The pieces can be pasted on cardboard, metal, wood, or other surfaces to cover and decorate objects. Sometimes the paper is pasted onto a clay former, which is later removed.

After papier-mâché has dried and hardened, its surface can be smoothed with sandpaper and painted. Lace, string, and other decorations can also be added. Papier-mâché can also be coated with polyurethane varnish or other substances to make it water-resistant and durable.

Papier-mâché was probably developed by the Chinese during ancient times. In the 1600's, the French became the first Europeans to use papier-mâché, creating boxes, trays, and other decorative objects. The English became noted for the beautiful furniture they made with the material during the 1800's.

See also **Doll** (The 1800's).

**Papillon** is a small breed of dog. It usually weighs 2 to 4.5 kilograms and stands approximately 28 centimetres high at the shoulder. Papillon is French for *butterfly,* and refers to the odd, butterflylike shape of the dog's ears. The papillon has a long, silky coat which may vary in colour. Its bushy tail is curved up over its back. This breed was developed in Spain in the 1500's, and is believed to be a relative of the chihuahua.

See also **Chihuahua; Toy dog.**

**Paprika** is a red seasoning. It is prepared by grinding the dried pods of a cultivated pepper plant called *capsicum* (see **Capsicum**). Paprika is less biting than red or cayenne pepper, and it has a sweeter taste. See also **Pepper.**

**Papillons were originally called dwarf spaniels.**

**Tea plantations** in the western highlands provide exports for Papua New Guinea and cash incomes for villagers who once existed entirely on the goods grown in their own gardens.

# Papua New Guinea

**Papua New Guinea** is an independent country located in the Pacific Ocean, north of Australia. It was formerly the Australian Territory of Papua and New Guinea. It became self-governing in 1973 and independent in 1975. It occupies the eastern half of New Guinea, the second largest island in the world. The western half of the island is Irian Jaya, a province of Indonesia.

Papua New Guinea also includes the Bismarck Archipelago, the northern part of the Solomon Islands, the Trobriand and D'Entrecasteaux islands, and the Louisiade Archipelago. Papua New Guinea lies about 160 kilometres across Torres Strait from Cape York Peninsula, Queensland, Australia.

It has great variety both in its land and its people. But much of it was unknown until the 1930's, when explorers entered its populous central highlands.

To the outside world, Papua New Guinea is famous for the fierce fighting that occurred along the Kokoda Trail in World War II (1939-1945), when Australian forces checked the Japanese southward thrust toward Port Moresby. The country is also especially known for its birds of paradise, which appear on its national flag. The huge copper mine on Bougainville Island is the country's most important single source of wealth.

Most of the people belong to the Melanesian racial group. In general, they follow the traditional, self-supporting subsistence type of life. For this reason, one out of five of the country's people live in small villages. The chief economic activities are growing coffee, cocoa, and copra; cutting timber; fishing; and mining. These activities were for many years controlled by *expatriates* (foreign residents)—mainly Australians—but now Papua New Guineans are beginning to take control.

Linguists have identified more than 700 languages in Papua New Guinea. Pidgin and English are the official languages. In Papua only, *Hiri Motu* or *Police Motu* is also recognized as an official language.

**Facts in brief about Papua New Guinea**

**Capital:** Port Moresby.
**Total land area:** 462,840 km². *Greatest distances between islands*—north-south, 1,174 km; east-west, 1,674 km.
**Elevation:** *Highest*—Mount Wilhelm, 4,509 m above sea level. *Lowest* sea level.
**Population:** *Estimated 1996 population*—4,443,000; density, 10 people per km²; distribution, 84 per cent rural, 16 per cent urban. *1980 census*—3,010,727; *Estimated 2001 population*—4,974,000.
**Chief products:** *Agriculture*—cocoa, coconuts, coffee, rubber, tea, timber. *Mining*—copper, gold.
**Money:** *Currency unit*—kina. One kina=100 toea.

## Government

Papua New Guinea is a constitutional monarchy and a member of the Commonwealth of Nations. The British monarch serves as head of state and is represented on the islands by a governor general. The national Parliament in Port Moresby is a single-house legislature with 109 members. Of the 109 members, 89 are elected from open electorates and 20 are elected from provincial electorates. Members are elected every five years by secret ballot. All men and women aged 18 years or over are entitled to vote.

The government of Papua New Guinea is of the same type as the British and Australian governments. It is led by a prime minister and a cabinet of up to 26 other members. This body decides policy and frames the laws of the country.

The general administration is in the hands of the ministers who head the various government departments in Port Moresby. Each of the 19 provinces is administered by a provincial government, led by a provincial premier. The 20th province, the national capital, does not have a separate government.

Provincial governments are responsible for education, health, business development, primary industry, and public works, such as roads. Their administrations are headed by provincial secretaries.

Within the provinces are the local government councils, in some places known as *community councils.* Members of these councils are elected by secret ballot by all people over 18 years of age. The government councils raise funds from rates on land, personal taxes, and subsidies and grants from the central government in Port Moresby.

The provincial governments are responsible for such local matters as health, hygiene, education, village water supplies, access road building, and the fostering of economic development. About 9 out of every 10 people in Papua New Guinea are served by these local government councils.

**Law and order.** The judicial system consists of the supreme court, national court, district courts, local courts, and village courts. Courts dealing with special matters include the land titles commission, coroner's courts, and mine warden courts. District courts deal with minor offences.

The Royal Papua New Guinea Constabulary enforces law and order. In areas where there are no police, the provincial governments have this responsibility. They appoint village peace officers to maintain law and order in separate villages.

**Social services.** The government provides most of the social services in Papua New Guinea. The Home Affairs Department promotes and coordinates all welfare services.

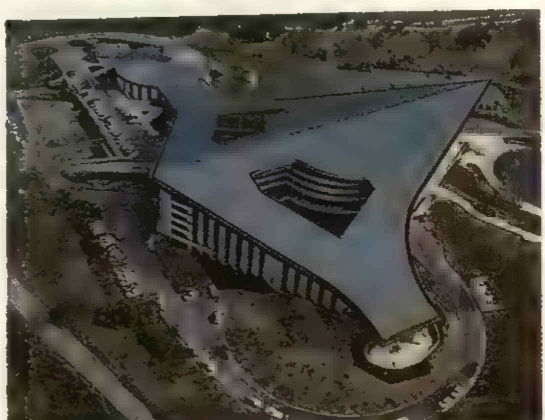
The public health department and the churches provide free medical services throughout rural areas. But major and provincial hospitals charge fees at different rates according to the service provided.

Four major hospitals serve as base hospitals for the four geographic regions of the country. These hospitals are in Port Moresby, Goroka, Lae, and Rabaul. There are also 16 provincial hospitals, 165 government health centres, 219 sub-centres, and 1,752 aid posts.

**Flag of Papua New Guinea**


**Coat of arms of Papua New Guinea**

**Symbols of Papua New Guinea** include the flag and coat of arms adopted in 1971. Both show the bird of paradise, which is the national *faunal* (animal) emblem. The flag uses the country's traditional colours of black, red, and yellow. The Southern Cross constellation on the flag signifies the country's historic relations with Australia and friendly relations with other Pacific countries. The coat of arms has a ceremonial drum called a *kundu* and a spear, which is a traditional weapon.



**The Parliament House** in Port Moresby is the meeting place for the national legislature of Papua New Guinea.

The government of Papua New Guinea does not provide pensions or social security benefits, such as unemployment benefits. The country's strong system of the extended family ensures that, in almost all cases, needy people will be cared for.

## People

**Population and ancestry.** The 4,112,000 people of Papua New Guinea are unevenly distributed throughout the country. The areas of greatest density in Papua New Guinea occur in the valleys of the Central Highlands; in the Torricelli and Prince Alexander mountains; near Popondetta, Madang, Port Moresby, Kerema, and Arawa; in the Rabaul hinterland of the Gazelle Peninsula; and on Manam, Karkar, Witu, and Trobriand islands.

Few people live on the rugged, forested slopes of the higher mountain areas. The large areas of poorly drained limestone country do not support large populations. Nor do the swamplands along the Sepik and Fly rivers and the Gulf of Papua.

Most Papua New Guineans belong to the Melanesian group. But, because there has been much movement and intermingling of peoples throughout the centuries, it is difficult to classify the people of the country into distinct racial groups. See **Pacific Islands.**

In former times, the people were divided into a great many groups. Each group had its own customs and language. Some of these groups have had many years of contact with travellers and are well known. For example, the Tolais of the Gazelle Peninsula of New Britain are known as a progressive group. The Trobriand Islanders of eastern Papua were made famous by the British anthropologist Bronislaw Malinowski. The large groups of the central highlands, such as the Bena Bena and the Gahuku people near Goroka, are also well known. The Motu of the Port Moresby coast were famous for their large seagoing canoes with sails shaped like crab claws. The people of Papua New Guinea have dark skin and frizzy hair. Anthropologists classify almost all of them as Melanesian.

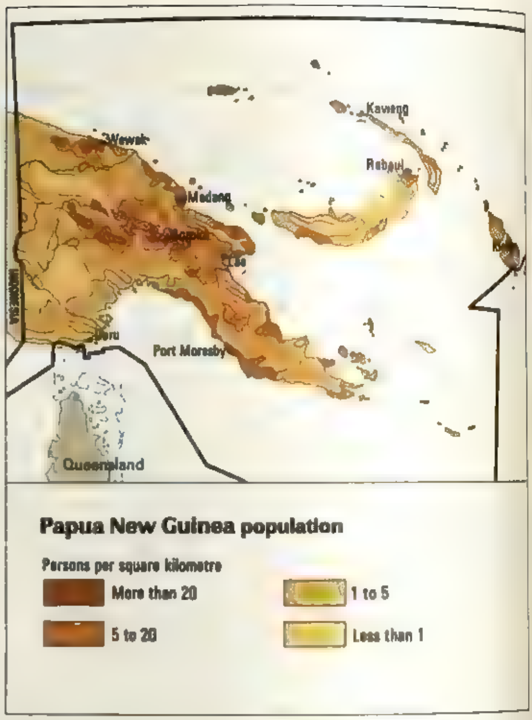
**Way of life.** Most of Papua New Guinea's people are farmers. They cultivate a plot of land until it loses fertility. They then clear and use other plots nearby until the fertility of the first plot is restored by resting.

This type of farming life depends very much on favourable landforms, soils, and climate. As a result, few people live in areas with unfavourable conditions, and there are regions of high population wherever environmental conditions are favourable.

Papua New Guinea is a land of diversity. The ways of life contrast greatly from the hot coast to the cool highlands and from coral islands to the fertile volcanic shores. Especially striking is the contrast between the patterns of traditional life, which remain strong in the country areas, and the sophisticated life of business people in the towns.

Tall, modern buildings rise in the towns. The shops carry a wide range of goods from other countries. In most villages, houses are still built following traditional patterns. Village people still produce most of the goods they need. Small food gardens supply most of the country's food. But large farms and plantations produce foods for export.

Some of the old ways have nearly disappeared. Fighting is no longer allowed. It has been replaced by rituals that take place between clans, involving bows and arrows and spears. The rituals arise from an argument over a pig, some land, or a woman.



**Papua New Guinea population**

***Environmental influences.*** Apart from the sparsely populated swampy plains of the Sepik and the Fly rivers, the country is mountainous, with high ridges and deep valleys. Turbulent streams and steep ridges have discouraged travel and have kept groups of people separate. This separation is probably the main reason for the development of numerous local languages and customs in the country.

Papua New Guinea lies within the tropics. Only Port Moresby truly has wet and dry seasons. The rest of the country experiences the monsoons from December to March, but it can have rain at any time. The climate is hot on the coast, and simple housing and clothing are common in the region.

Inland, the temperature drops as the land rises in height above sea level. In the great high valleys, conditions can often be cold. In the higher parts of the central highlands, people have to cope with occasional frost at night. Houses are built close to the ground with thick walls for warmth. Fires are kept burning because the people have not developed more elaborate clothing. In the past, they rubbed their bodies with pig fat to keep warm.

***Food.*** Most communities grow their own food. Animal foods are highly valued everywhere. In the warmer parts, *taro*—a lilylike plant with a large starchy *corm* (bulb)—grows in poorer or wetter soils. Long climbing vines called *yams,* which have tubers like long potatoes,


## Papua New Guinea map index

### Cities and towns

| | | | |
|---|---|---|---|
| Aitape | 3,366. | B | 2 |
| Alotau | 4,310. | E | 5 |
| Ambunti | 1,030. | B | 2 |
| Angoram | 1,830. | B | 2 |
| Arawa | 12,623. | C | 8 |
| Baimuru* | 661. | D | 3 |
| Balimo | 1,110. | D | 2 |
| Banz* | 919. | C | 3 |
| Bereina | 585. | E | 4 |
| Bogia | 762. | B | 3 |
| Buin* | 677 | D | 8 |
| Bulolo | 6,801 | D | 4 |
| Daru | 7,149. | E | 2 |
| Esa'ala | | E | 6 |
| Finschhafen | 756. | D | 4 |
| Goroka | 18,797. | C | 3 |
| Hoskins | | C | 5 |
| Hutjena | | C | 8 |
| Kabwum | | C | 4 |
| Kagua | 680. | C | 2 |
| Kaiapit | 515. | C | 3 |
| Kainantu | 3,809. | C | 3 |
| Kandrian | 621. | C | 5 |
| Kavieng | 4,566. | B | 6 |
| Kerema | 3,354. | D | 3 |
| Kerowagi* | 1,187. | C | 3 |
| Kieta | 3,445. | C | 8 |
| Kikori | 816. | D | 2 |
| Kimbe | 4,680. | C | 5 |
| Kiunga | 1,332. | C | 1 |
| Kokoda | | E | 4 |
| Kokopo | 2,194. | B | 6 |
| Kukipi | | D | 3 |
| Kundiawa | 4,298. | C | 3 |
| Kwikila | 1,019. | E | 4 |
| Lae | 61,682. | D | 4 |
| Lalagam* | 864. | C | 2 |
| Lorengau | 3,847. | A | 4 |
| Losuia | 575. | D | 6 |
| Lumi | | B | 1 |
| Madang | 21,332. | C | 3 |
| Maprik | 1,121. | B | 2 |
| Mendi | 4,131. | C | 2 |
| Menyamya | | D | 3 |
| Miak* | | C | 3 |
| Minj* | 869. | C | 3 |
| Morehead | | E | 1 |
| Mount Hagen | 13,642. | C | 2 |
| Namatanai | 744. | B | 6 |
| Nomad | | C | 1 |
| Panguna | 3,487. | C | 8 |
| Popondetta | 6,343. | E | 4 |
| Port Moresby | 122,761. | E | 4 |
| Rabaul | 14,973. | B | 6 |
| Saidor | | C | 4 |
| Samarai | | E | 6 |
| Sogeri* | 1,188. | E | 4 |
| Sohano | | C | 7 |
| Talasea | | C | 5 |
| Tapini | | D | 4 |
| Tari* | 614. | C | 2 |
| Tufi | | E | 5 |
| Vanimo | 3,051. | B | 1 |
| Wabag | 1,518. | C | 2 |
| Wau | 2,374. | D | 4 |
| Wewak | 19,554. | B | 2 |
| Wonenara | | D | 3 |

*Does not appear on the map; key shows general location.
Source: 1980 census.

prefer more fertile soil. In the wet, swampy basins of the Sepik, Ramu, and Fly rivers, sago palms grow and form the main food supply. Coconuts are an important source of nutrition in warm areas. People everywhere also eat some smaller nuts, leaves, fruits, and vegetables. These foods add flavour and variety to their diet. At higher altitudes, yams and taro do not grow well and sweet potato is the main crop. Europeans have introduced other vegetables and fruits, including maize, pawpaws, and tomatoes. Many have become important foods.

Vegetable diets tend to be short of protein. For most people in Papua New Guinea, pork and chicken provide the only meat. But many small animals are hunted, and fish is important on the coasts.

*Clothing.* Eastern Papua is famous for its so-called *grass skirts.* In fact, grass is rarely used. The strips of fibre hanging from a waist cord are made from bark, leaves, or stems. These skirts are the usual women's dress in most districts. They sometimes have only front and tail pieces, leaving the thighs bare. The basic men's garment is most often bark cloth worn as a waist band and passed between the legs.

Throughout the country, people wear many ornaments. In the western highlands, men make wigs decorated with flowers. Necklaces and bracelets of seeds, shells, or woven rattan sometimes hold fragrant leaves. Only in eastern Papua has tattooing been general. But body paints are common everywhere. People wear especially elaborate dress for ceremonies. On these occasions, they wear the magnificent feathers of birds of paradise, parrots, and other birds.

People almost everywhere wear shorts of European design. Some women retain traditional skirts, but most of them wear simple dresses. Traditional styles are reserved for ceremonial occasions.

*Houses.* The Kiwai at the mouth of the Fly River build great communal houses as much as 150 metres in length with raised floors in which the whole village lives. Inside, each family has its own private section. Elsewhere, most families build their own separate houses. But in many places, men— especially those who are not yet married—sleep in separate men's houses. Most houses have little decoration. But some of the men's or club houses are large, with elaborately carved main posts. On the Papuan coast and Manus Island, some villages are built on pile foundations in shallow water off the beach. In parts of the Sepik, where the plains are drowned by annual floods, houses are built high above the ground. Also in the Sepik district are the famous *haus tambaran.* These spirit cult houses have elaborately painted fronts and are used solely for ritual purposes.

The main method of construction is the same everywhere. Nails are often used today, but formerly the pole framework was tied together with rattan. Floors that are raised above the ground are made of palmwood or bamboo. Most roofs are made of kunai grass or sago palm leaves. Walls are made of bark, bamboo, sago leaf stems, or plaited mats.

In the past, the National Housing Commission built homes in towns out of imported fibreboard. But now they generally use local timber.

*Tools and weapons.* Cutting tools are essential in most cultures. In former times, people everywhere used traditional axes and *adzes*—cutting tools that are like axes, except that their blades are set at right angles to the handles. Blades were made from stone or volcanic glass. Large ceremonial axes are still made in the highlands and sold to tourists. But no other stone tools are made today. Effective knives are still made from split bamboo, which is usually easy to obtain. Some knives are made of bone.

The most important gardening tool, apart from the axe, has been the digging stick. It is simply a stake with a sharpened end that has been hardened in the fire. Bows made from palmwood, or sometimes bamboo, were the most important fighting weapons. Arrow shafts, made from straight cane, were fitted with various types of arrowheads suited to varied purposes. Weapons traditionally used for fighting are still used today for hunting. The ownership of shotguns is subject to strict government control through licensing. Villagers catch wild animals by using nets, traps, and snares. Government and church organizations encourage the people of Papua New Guinea to use simple tools rather than complex machinery.

**Families** now tend to dress in traditional costume only on special occasions.

*Work.* Village life is often busy. Men and women each have separate tasks. There are also some jobs that must be done by both together.

In general, women look after the household affairs. They watch over the children, prepare the meals, and do much of the ordinary work in the gardens. In the gardens, they plant and weed. Several times a week they carry heavy loads of vegetables back from the garden plots to their houses. In their spare time, they may make net bags or prepare clothing. In some parts, they make clay cooking pots.

Men have less regular work and enjoy more periods of leisure. But the work they do is often harder and sometimes more dangerous. Formerly, the men had always to be ready to protect their village and families from attack. Today, their most important work involves building houses and clearing the forest for gardens. Men have the major role in religious rituals and the responsibility of leadership. They fish, hunt, and make such important items as wooden bowls, tools, and canoes.

There are few specialists. Each person is able to do most of the tasks that are necessary for village life. Even in past times, magic was known only by a few experts.

Today, about 200,000 people in Papua New Guinea are in paid employment. The biggest employer is the government itself.

*Social organization.* In most parts, the main unit of population is the village. Some villages are large. But most have fewer than 500 people. In parts of the highlands, there are no real villages, because the people live in separate houses scattered over their land. In the highlands, villages were built only when the whole group gathered together for a period of religious rituals. Many villages are built around clear open spaces where public events take place. Sometimes important buildings such as men's houses or churches are built at the centre. In some cases, the village may, in fact, consist of a series of separate small villages built close together.

The most important bond that ties people together in a community is kinship. People who are related always regard each other as friends and help each other. Most villages contain one or more groups of people who are descended from a common ancestor and are known by a special name. In many places, people belong to the descent groups to which their father belonged. In other places, the group membership of the mother is thought to be most important. The Tolais are an example of the latter. The descent groups own the land. But individuals may have special rights in limited areas.

*Community life.* Family ties are strong. When people need help in building a house or making a garden, they first turn to their relatives for assistance. Other people in the village also help and they, of course, will be able to ask for help in return. Kinsfolk from other villages may also be called on if the task is important.

Kinship is the most important link that ties communities together. But there are other associations, such as clubs. Clubs are found mainly in coastal areas. Men who join them behave like brothers and share in maintaining the club house.

Few communities have chiefs who inherit their position. Most leaders do not hold formal office but are informally recognized as important people, or *big men.* They gain prestige through their skill as fighters, knowledge of important magic, ability as public speakers, and willingness to work hard and use their wealth wisely.

Leaders count on their kinsmen to support them, but they can be said to have influence rather than power. A community may have several big men who together fill all the functions of leadership. Today, people are chosen by election for local government or community councils, provincial government, and the national Parliament.

Communities have strong traditions, which do not change often and are recognized almost as laws. But, as situations change, new rules have to be made from time to time. People in the villages talk about changes. When the leaders feel there is general agreement, they tell what is to be done.

A leader's prestige is not easily challenged. Rules are enforced mainly by public opinion. People who break them feel strong shame. In some cases, traditional rules are enforced by the fear that the spirits of the ancestors may impose a punishment. People who break rules may be fined or made to pay compensation to someone who has been wronged.

*Family life.* The family is the most important unit in Papua New Guinea society. Family members cooperate in every aspect of life. In some areas in the highlands, husband and wife live in different houses, which may be more than a kilometre apart. But even in those communities, husband and wife are closely joined to each other by social ties.

Marriage is the main event in most people's lives. Young men and women may court each other sometimes secretly and sometimes at special courting parties. In other cases, young people may leave it to their families to arrange a marriage for them.

**Haus tambaran,** such as this one at Maprik, are highly decorated sacred houses. Women are forbidden to enter them.

There is almost always much ceremony, including a payment known as the *bride price.* This payment of valuable items is collected from relatives by the bridegroom's family. According to custom, they give it to the bride's relatives to make the marriage proper. The bride is not bought like a slave. She transfers her loyalty from her own family to her husband's family. In former times, some men, particularly leaders, had more than one wife, but this practice is becoming uncommon.

***Life of children.*** Children are the heart of the family, and parents take great pride in them. Mothers keep their babies always with them. Some of them carry their babies in net bags hung from their heads wherever they go. As the children grow older, boys spend more time with their fathers and other men. Where there are men's houses, they may leave to sleep with the men. But they may still be fed at the mothers' houses. Boys learn from the village men the skills they must master as they grow up. Girls learn most of their skills from their mothers by helping in the house and garden.

Children do not have many special toys. But items such as tops, toy boats, and balls are traditional. Children often play games, mimicking the jobs their parents do. For example, boys play at hunting village chickens and learn how to stalk prey and to throw accurately. In copying their mothers, girls learn about food and gardening. For children, play is a way of learning the work they will do as adults.

The life of children is often free. They are welcome in most neighbouring houses because so many people in the village are related to them. While young, they may have little formal training. But, at some point, boys may have to go through special ceremonies and be instructed in tribal secrets.

***Trade.*** Former communities were seldom entirely self-sufficient. Salt, for example, was a highly prized item that could be obtained only from the sea or from occasional brine springs in the mountains. People who had no salt supply had to obtain it by trade. They exchanged other foods, or such valuables as bird-of-paradise plumes, for the salt.

Most trade between groups was done by individuals who were traditional exchange partners. Some groups had important trading associations. There were important trading circuits on the coasts. In these circuits, after elaborate preparations of large canoes, long voyages were made across open seas to trade food, pottery, ritual valuables, and many other items. The people of Trobriand and other islands in the Massim area of eastern Papua called their exchanges the *kula.* On the Papuan coast, Motu men took voyages that lasted up to three months. They exchanged clay pots for sago flour in villages of the Gulf district. A major part of their food came from this source. These voyages have mostly ceased, but people still trade in foods, minor locally produced luxury goods, and ornaments on a small scale. Most people today trade their goods for money, rather than bartering one type of item for another.

***Fighting.*** Before European colonists established central government, villages were always subject to attack. Most fights started to revenge an insult to a leader or an injury to a villager. Accusations of sorcery or theft could also cause an attack. Disputes over land boundaries occurred often in some areas. But generally, the only groups who fought to expand their territory lived in the densely populated Chimbu area of the highlands. In other parts of the country, land was plentiful, and an enemy's ground was not taken over after a conquest.

Most often, fighting only amounted to the sudden secret ambush of a small group working unprotected in a garden, or a stealthy raid at night on a house on the edge of the village. Major pitched battles were less common, and a fight rarely lasted more than a day.

Shedding of blood was thought to be an evidence of achieving manhood for young men. Headhunting was not normally carried on, but enemy heads were occa-

**Painted carvings** are among the traditional crafts of Papua New Guinea that can be seen at the Port Moresby Museum.

**Melanesian dancers** wear traditional headdresses with the feathers of a bird of paradise on ceremonial occasions.

sionally preserved. At worst, the losers were dispersed to take refuge with friendly groups. Those defeated were not made slaves. Today, the Inter-Group Fighting Act of 1977 gives the authorities special powers to punish groups in areas where fighting takes place.

Spears, axes, clubs, and daggers were used as weapons everywhere. In eastern Papua, slings were used. But in other parts, bows and arrows were the most important weapons. Fighting shields were made of bark, woven rattan, or carved planks.

**Languages.** The people who live in Papua New Guinea speak a large variety of languages. Some of these languages have not yet been studied. But linguists have distinguished more than 700 languages, in addition to many minor dialects.

English, Pidgin, and Hiri (which means *trade*) Motu are the official languages. English is the main language used in almost all schools. The number of people who speak English is growing rapidly. But the most widely spoken language is still Pidgin. It developed around Madang and Rabaul at the end of the 1800's. Pidgin, which began as a trade language, used many English words in a Melanesian grammar. At first Europeans and local people used it to communicate with one another, but as more Papua New Guineans have travelled around their country, it has come into wider use.

In the southern or Papuan section of the country, a variety of the original Port Moresby language called *Hiri Motu* or *Police Motu* is understood by many people. Official government publications are printed in English, Pidgin, and Hiri Motu.

The village languages are of two types. The Austronesian types are spoken by the Melanesian peoples. Non-Austronesian languages are spoken by inland peoples. Some languages have many speakers. Enga has 143,000 and Kuanua (Tolai) has 64,000. But most languages are spoken by only about a thousand people. Many of these languages are now being studied, and the Summer Institute of Linguistics teaches people to read and write in their own languages. However, little has been printed in any of them except Pidgin.

**Religion.** There are many beliefs about spirit beings. In most parts of Papua New Guinea, people believe that spirits of the dead have the power to punish people who ignore customs or neglect proper ceremonies. The ancestor spirits also help people, especially to defend their land against enemies.

Other important spirits are also respected. These non-human spirits are often thought to live in deep pools, large trees, or other special places. But some spirits are associated with natural events such as winds or with carved emblems stored in spirit houses.

The major concern of religion is fertility. A garden that fails to grow can cause a catastrophe, and villagers often seek the help of spirits. Most rituals make much use of magic. Many spells that seek to force spirits to serve the interests of men are carefully guarded secrets. Religious activities mainly involve men, but women also have their own rituals.

Christianity has been introduced widely, but traditional rituals are still frequently preserved. The major Christian denominations are Roman Catholic, with 975,000 people; Lutheran, with 650,000; United, with 350,000; and Anglican, with 220,000.

The introduction to the national Constitution states: "We, the people of Papua New Guinea, pay homage to the memory of our ancestors, acknowledge the worthy customs and traditional wisdom of our people and pledge ourselves to guard and pass on to those who come after us our noble traditions and the Christian principles that are ours now."

***Burial customs.*** In many places, villagers formerly held elaborate funeral rituals because they believed the spirits of the dead stayed near the bodies after death. Many methods of disposing of the body are used. In some areas, custom allowed a choice among several methods. Burial in cemeteries is now the most common. But formerly, bodies were preserved in houses or buried under the floor. Sometimes they were exposed on platforms and allowed to dry like mummies. They might then be placed in remote caves. In some island regions, people buried the dead at sea. On other islands, cremation was used.

Articles that belonged to the dead might be left with the corpse or publicly destroyed during the funeral ritual. Offerings of food and drink were often placed on tables for the spirit to eat. But in most cases, there was finally some kind of farewell ritual, after which the spirit of the deceased was thought to leave for the land of the dead.

Bones were frequently recovered—often the skull—and kept by the family. In both New Ireland and the Sepik area, skulls were used as bases for clay models of the head, and the models were preserved as memorials. In the southern highlands, miniature houses were placed on poles beside trails. Here, ancestors' spirits stayed and kept watch over their lands.

**Art** is often closely connected with religious expression. Images, dance masks, paintings, and songs associated with the spirit world occur in a rich variety. The people of Papua New Guinea express their feelings and traditions in music and dancing.

**Pig feasts** are important ceremonial occasions in the highlands. Pigs are a source of protein and a symbol of prestige.

Papua New Guineans prepare beautiful headdresses and clothing for special ceremonies. The *haus tambaran* of the lower Sepik River are famous for the large and symbolic paintings on their tall façades.

The people make music with lip and nose flutes and wooden or gourd trumpets. They beat out rhythms on hand-drums made with skins or on wooden gongs made of hollowed logs.

Formerly for ancestor rites in the highlands, people painted brightly coloured graphic symbols, using natural ochres or vegetable dyes. Elaborate face and body painting were also common throughout the country.

The National Theatre Company performs traditional dance. The National Arts School also encourages the preservation of traditional skills.

### Education

Papua New Guinea's major concentration of educational effort is on developing a system of education that will prepare Papua New Guineans for life in their rapidly changing society. English is the language of instruction in all schools, but most schools follow a locally developed curriculum.

Education at all levels is available to the people of Papua New Guinea through schools run by the government and by churches. Government and church schools are combined for planning and staffing purposes, but they retain their separate identities. The national education board plans educational development. Except for denominational church schools controlled by the Seventh-Day Adventists, all schools are staffed by a common teaching service, and all teachers are paid with funds from the government department of education.

Education is not compulsory. About 335,000 children—about 60 per cent of the country's school-age population—attend community schools. Children attend for six years, beginning at the age of seven. Fees are payable by parents at a rate fixed by the school board. Books and equipment are provided free.

Before World War II, the government operated only a few schools. Education was left to the missions, which provided a low level of primary education in the local language. After the war, the government established a department of education. It increased the number of primary schools and set up secondary and technical schools. It also set higher standards for education and began giving financial aid to the mission schools that met these standards. New courses were put into operation to meet the needs of the people.

During the 1960's, teaching in all Papua New Guinean schools was based on the curriculum of New South Wales, Australia. In the early 1970's, curriculum materials specifically related to Papua New Guinea began to develop in some of the subject areas. This movement culminated in the establishment of a curriculum unit in 1975, and a new local syllabus was introduced.

Children of expatriates, who have come from all parts of the world to work in Papua New Guinea, are taught in international primary schools. These schools follow a largely Australian curriculum. Most expatriate children of secondary school age are enrolled at boarding schools in Australia. Papua New Guinea has international secondary schools in Port Moresby and Lae.

After six years of primary education, selected students proceed to a four-year secondary course leading to a school certificate. About 40,000 students attend the 94 provincial high schools. Other students take special courses in the 98 vocational schools. These vocational courses train them in skills that are likely to be of value in village life. After two years of secondary education, qualified students may transfer either to one of the technical colleges or to one of the special training colleges operated by various government departments.

**Computers** have helped establish Papua New Guinea as a modern nation.

Specialist training is provided at such institutions as the Papuan Medical College, the dental college, the administrative college, the police training college, the Pacific Island Regiment College, the Posts and Telegraphs Training School, the Kavieng Fisheries College, and the Popondetta and Mount Hagen Agricultural Training Institute. Training is also provided at the Vudal Agricultural College, near Rabaul, and the Forestry School at Bulolo. More than 2,200 teachers train at the 9 teachers' colleges. A further 540 teachers specialize in secondary school teacher training at a college of the university, located at Goroka.

The University of Papua New Guinea was established at Waigani, a suburb of Port Moresby, in 1966. It offers students degrees in arts, science, law, medicine, economics, and education. Students seeking entrance to the university must reach matriculation standard or may attend a two-year college course to attain that standard. The University of Technology at Lae offers degrees and diplomas in such technical fields as civil, electrical, and mechanical engineering; architecture; building studies; accountancy; business studies; and surveying.

### Cultural changes

The traditional cultures of Papua New Guinea are changing more rapidly in some areas than others. In remote areas, change is still slow. But in districts close to major towns, where the presence of plantations has brought much new wealth, the modern goods that make

Europeanized life possible are more easily obtained. In these areas, most children go to school and their social lives are influenced by ways of life outside their villages. Young people who leave home to work in distant areas return with many new ideas. Many leave the villages to live permanently in towns.

Old skills and ideas are sometimes lost as new ones are learnt. For example, when many people accepted at least some elements of Christianity, many traditional village ceremonies that had been performed for hundreds of years began to lose their importance.

As families earn money from new crops and from employment, they are able to buy food and other essentials and no longer depend so much on the cooperation of kinsfolk. Money and employment are bringing people into new kinds of relationships that are often less personal in nature. Education has brought to many young people a chance to obtain a good job. Now they are no longer dependent on the support of the elders, whose ways are rooted in traditions. The most widespread result of rapid change is probably the loss of unity of the family and the loss of the feelings of respect for maturity on which that unity depended. But one of the nation's strongest forces remains the system of *Wantok*—Pidgin for *one-talk*, a person who speaks the same language and is therefore related.

**European influences.** In most cases, the first change brought by Europeans was the banning of all fighting. As peace between villages became more common, people began to move more easily between villages. The rapid growth of general languages such as Pidgin, Hiri Motu, and, more recently, English, has greatly increased the ease with which people can communicate with each other. Many people can now read and write. Most villages have at least one radio. Thus, news travels quickly, and most people hear about other groups of people in the country and new developments in the towns. People are becoming increasingly aware that they belong to a community that is national, not one that is limited to their own local village.

Another major change brought by Europeans was the introduction of money. At first, money was used to pay for work done on plantations. But as families began to grow crops for sale, more people began to get cash incomes. Today, many people manage small businesses, such as village shops, and a few quite large businesses are operated by local people.

At first, missionaries maintained the schools, but education eventually came under control of the Australian administration. Schools have taught new skills, and now local people hold many jobs previously held by Europeans. Papua New Guinea can now take a place with the modern nations of the world.

**Difficulties of change.** Despite the changes that have come, many people still live in small villages and do not often travel far from home. Rivalries still exist, particularly among older people. Each group still proudly preserves its own customs and language. Many children have no school to go to and have had few opportunities to learn about the people who live in other parts of the country. Many of these small villages are remote and will be difficult to develop. Because of the rough mountains, the main towns are still not joined by a good network of roads. Many people in Papua New Guinea can travel only if they walk, which is slow, or fly, which is expensive.

**Making a modern nation.** In the early 1970's, the prime minister, Michael Somare, outlined some ideas that he believed had to be accepted by the people in order for the country to progress as a nation. These ideas became known as the *Eight-point Improvement Plan.* Somare's points were: (1) to increase the proportion of the economy controlled by Papua New Guineans; (2) to make incomes and public services more equal throughout the country; (3) to slow the growth of towns by developing more village industry and agriculture and


**Warriors** wearing traditional costume, *left,* are an increasingly rare sight.

by giving more authority to local government; (4) to develop small-scale businesses and services rather than depend too much on large factories; (5) to achieve self-reliance by producing more goods in Papua New Guinea, thereby reducing expensive imports; (6) to raise more money for government from local sources so that the country will be less dependent on aid from other countries; (7) to help women gain a more equal role with men in society; and (8) to develop the style and type of government best suited to achieve these goals.

The scenery of Papua New Guinea varies from the coral-rimmed Trobriand Islands, with their many beaches that feature skin diving and fishing, to the rugged mountain country of the interior, where massive ranges flank the broad valleys.

Many of the roads radiating from major ports offer spectacular scenic drives. Visitors can drive from Lae, on the coast, along the Highlands Highway through the Markham Valley and the dramatic Kassam Pass to Goroka, Mount Hagen, and Wabag, and on to Laiagam in the Enga district. A branch road from Mount Hagen goes south round Mt. Giluwe to Mendi in the southern highlands.

The most unusual and exciting attractions for visitors to Papua New Guinea are the customs of the local people. Tourists visiting the country areas, especially the highland regions, can learn about a wide variety of housing, speech, and dress.

Tourists can watch as groups of people, decorated with natural dyes and wearing wigs, shells, or feather headdresses, gather at a village dancing ground to feast and celebrate. The agricultural shows at Goroka and Mount Hagen attract as many as 40,000 spectators each year. People from groups around these towns attend the agricultural shows to display their traditional dancing and costumes.

The culture of the people of Papua New Guinea attracts collectors, photographers, and artists. In the Sepik, Buin, and Trobriand Islands areas, carving and weaving are highly developed. The people express their ways of life in ancestral masks, carved figures, stone

**Mud men** representing bad spirits at a *singsing* (feast), like this one at Goroka, can sometimes be seen by tourists.

**The agricultural show** at Goroka has become a major tourist attraction. People wearing traditional clothing often join in the displays. Local groups from a large area around Goroka take part.

axes, basketware, and fish traps. People throughout the world know about the people of the Sepik district for their decorated *haus tambaran,* and the people of the Hagen area for their ceremonial stone axes.

The Hiri Moale Festival in Port Moresby, celebrated each September, is an important cultural event. It commemorates the historical trade between the villages around Port Moresby and the people in the Gulf Province. It features canoe races, processions, choirs, string bands, *singsings* (feasts), and a Hiri queen contest.

### Land and climate

**Location and size.** Papua New Guinea consists of the eastern part of the island of New Guinea; the Bismarck, D'Entrecasteaux, and Louisiade archipelagos; and the northern part of the Solomon Islands. This group of 600 islands is the submerged eastern end of the great arc of mountains that stretches through Indonesia, Malaysia, and Thailand, to join the Himalaya in northern Burma.

The island of New Guinea stands on the Sahul Shelf, a submarine extension of the Australian continent. The island is separated from Australia by the shallow Torres Strait, which is only about 160 kilometres wide. Other islands in the strait are Australian territory but lie closer to Papua New Guinea.

The political boundaries of Papua New Guinea enclose a total area of 2,275,000 square kilometres, of which only about 460,690 square kilometres are land.

**Land regions.** Papua New Guinea has six major land regions. The backbone of the main island is a large chain of mountain ranges. It varies in width from 80 kilometres in southeastern Papua to 200 kilometres in the central part of the mainland.

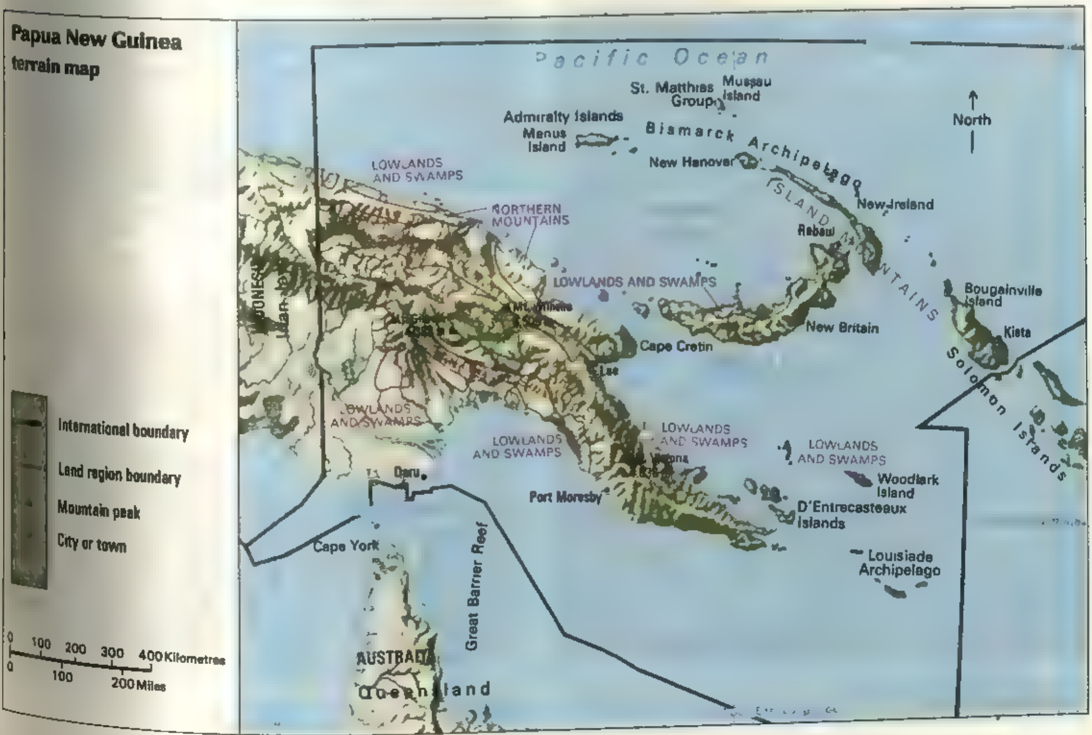
The heights of all the major ranges in Papua New Guinea exceed 3,000 metres above sea level. Mount Wilhelm is 4,509 metres high. Mount Giluwe is 4,368 metres, Mount Kubor is 4,359 metres, and Mount Victoria is 4,036 metres.

These mountains are Papua New Guinea's highest peaks. Most of the mountain ranges are steep and are cut by deep, heavily forested valleys. But in the wider, central part of the country, there are numerous broad, grass-covered valleys, such as the densely populated Asaro, Chimbu, Wahgi, Tari, Mendi, and Lai-Lagaip valleys.

The northern mountains extend along the north coast, parallel to the main, central chain. The mountains stretch from the much lower Bewani and Torricelli ranges in the west to the rugged Finisterre and Saruwaged ranges in the Huon Peninsula.

The Bewani and Torricelli ranges are 1,000 to 1,200 metres in height. The highest peaks on the Huon Peninsula reach heights of more than 4,000 metres. A trough-like depression lies between the central and northern mountain chains. In this depression lie the valleys of the Sepik, Ramu, and Markham rivers. The area between the mountain ranges consists mostly of low-lying, swampy land.

In western Papua, a region of foothills borders the central mountains. This foothill region consists of the Bosavi lava plateau in the west, rugged limestone plateaus in the centre, and rugged low mountains in the east where the Kukukuku people live. Much of the river drainage in the limestone is underground or in deep, steep-sided valleys. To the south of the foothills are extensive swamplands that extend to Irian Jaya. The



swamps are formed from material that has been washed down from the highlands by the rivers.

The islands of Papua New Guinea are mainly mountainous and rugged and have numerous active volcanoes. They are flanked in places by coastal lowlands on which most of the people live. Many smaller islands are of volcanic or coral formation. Minor earthquakes are common in many places.

Geologists believe that the coast is sinking in the Gulf of Papua and that much of the northern coast is rising. In the south, the sea has flooded into the valleys in many places to form safe harbours. Coral reefs flank much of the coast. Some of the reefs protect harbours, but many endanger shipping.

In the north, raised coral reefs brought to the surface by the upward movement of the land are common. They weather into soils that are most suitable for growing coconuts.

**Rivers.** Most of Papua New Guinea has an extremely high yearly rainfall of more than 2,500 millimetres. For this reason, many areas of the highlands have rivers that are large in volume if not in length. These fast-flowing streams carry silt and mud onto floodplains lower down.

The Fly River and its large tributary, the Strickland, form the major river system. The Fly rises in the Hindenberg Range and flows more than 1,100 kilometres to its estuary in the Gulf of Papua. Small vessels can sail up it for nearly 800 kilometres.

The Sepik River, another large stream, is close to the Fly, but it flows north and east for about 1,100 kilometres to the northern coast near the Schouten Islands. Small vessels can sail up it for about 500 kilometres, but it floods frequently. It is bordered mainly by swamps.

The Ramu River rises in the central highlands and flows through large areas of swamp before reaching the sea near the mouth of the Sepik River. The Purari also rises in the central highlands. It flows through the wide, well-populated valleys, then drops through huge gorges onto its delta area in the Gulf of Papua. The Wahgi River also rises in the central highlands.

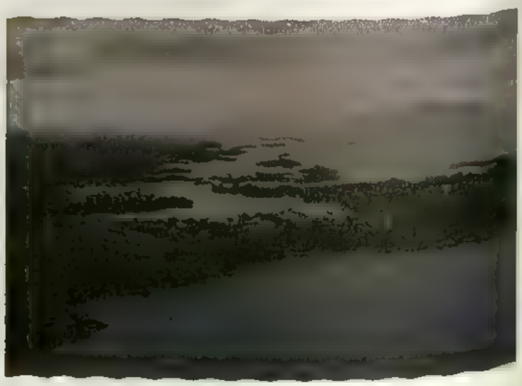
Other important rivers are the Erave, a tributary of the Purari, and the Kikori, Markham, Jimi-Yuat, Wawoi, Turama, Waria, Musa, and Lakekamu.

**Climate.** Except in the highlands above 2,000 metres, Papua New Guinea has a hot, humid climate. From May to October, winds blow steadily from the southeast. From November to April, winds are variable but mainly blow from the northwest. Areas on the outer mountain flanks and foothills, and on the adjoining lowlands, have over 2,500 millimetres of rain a year. More than double this amount falls in areas along the south coast of New Britain and inland from the Gulf of Papua. The Port Moresby district has only 1,000 millimetres a year.

In all areas, the temperature remains nearly constant throughout the year. In the lowlands, the average daily temperature is about 28° C. At 3,000 metres, the daytime average is about 18° C and the nights between −4° C and 5° C. Frosts often damage crops in the highlands.

**The Sepik River** is bordered by swamps. It floods frequently, and houses along its banks are built on stilts.

**Mount Michael,** near Goroka, is one of the highest peaks of the highlands of Papua New Guinea.



**Madang,** on the coast, has a large protected harbour. It is one of the main copra-producing districts.

The humidity is high at all times and in all parts. On the lowlands, it ranges between 70 and 88 per cent. The humidity, together with the high temperatures, makes the climate unpleasant. In the highlands below 2,300 metres, the humidity ranges between 50 and 75 per cent. This level of humidity, and generally lower temperatures, creates pleasant living conditions.

**Natural resources.** The important natural resources of water, soil, grasslands, forests, and minerals in Papua New Guinea are extremely variable both in quality and quantity.

*Water.* The generally high rainfall ensures plenty of moisture for the growth of most crops in most areas. But the seasonal distribution restricts agriculture in several regions.

Spells of dry weather or of extremely wet weather are a hazard in all parts of the country. Many streams that pour from the mountains could be used to produce hydroelectricity. But physical problems and the high costs involved in building dams, power stations, and power lines for distributing the electricity present major obstacles.

*Soils.* Only about 5 per cent of Papua New Guinea has soils of high fertility. Landforms and soils suitable for agriculture occupy less than a quarter of the total land area. The main fertile soils are those recently formed by rivers and volcanoes. Other soils are invariably heavily leached and have little fertility.

*Grasslands.* Most of the grasslands in Papua New Guinea are artificially formed, and result from repeated burning and clearing for gardens. The grasses in them grow luxuriantly. But they are only of moderate value for cattle fodder. The well-distributed rainfall keeps the grasses green for most of the year.

*Minerals.* Papua New Guinea has a wide range of minerals, including gold, copper, and natural gas. Many of them are in rugged, mountainous areas that are difficult to mine.

*Plants and animals.* More than 80 per cent of Papua New Guinea is covered with rain forests. Massive trees reach heights of more than 40 metres in the lowland and foothill rain forest zone. Here and in the lower *montane* (mountain) zone—from 1,000 to 3,000 metres above sea level—the tall trees form a high covering that cuts off sunlight and prevents most shrubs from growing. Many of the trees—especially taun, kwila, erima, kamarere, and araucaria—yield valuable timber.

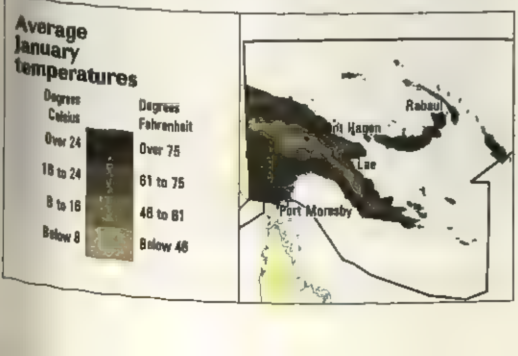
Between 2,900 and 3,400 metres above sea level, forests grow in almost perpetual mist and drizzle. Trees in this misted, mountain forest grow low and crooked. Lichens and mosses cover most of the trees and also often form a thick carpet on the ground. Above 3,400 metres lies the subalpine and alpine zone, areas of grassland and tundra. The lowlands around Port Moresby and north and south of the Fly River estuary are savannah country. Trees there are generally low and scattered, except in narrow belts along streams. In other coastal areas, mangrove and nipa palm swamps are common.

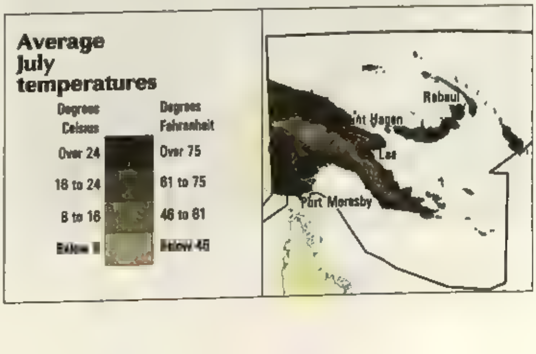
Papua New Guinea has about 100 *species* (kinds) of mammals. *Marsupials* (mammals that carry their young in a pouch) include wallabies, possums, bandicoots, and a meat-eating group called *dasyures*. People keep pigs, dogs, and poultry, all of which were introduced by the early settlers long before Europeans arrived. The 300 species of reptiles include about 70 species of snakes, including 14 varieties of sea snake, taipan, and death adders. There are also about 150 varieties of lizard ranging from geckoes and skinks to the huge monitor lizards called *goannas*.

Crocodiles and tortoises live in the rivers and around the coasts. Some estuarine or saltwater crocodiles measure up to six metres in length. Crocodile farms have been established in several parts of the country. These farms breed crocodiles for their skins, which can be sold at high prices for making shoes and bags. Birds include the flightless cassowaries and 33 of the 42 known species of the bird of paradise.

**Average monthly weather**

| | Port Moresby | | | | | Mount Hagen | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Temperatures C.° | | Temperatures F.° | | Days of rain | Temperatures C.° | | Temperatures F.° | | Days of rain |
| | High | Low | High | Low | | High | Low | High | Low | |
| Jan. | 31 | 23 | 88 | 73 | 19 | 24 | 14 | 75 | 57 | 22 |
| Feb. | 31 | 23 | 88 | 73 | 21 | 25 | 15 | 77 | 59 | 25 |
| Mar. | 31 | 22 | 88 | 72 | 20 | 25 | 15 | 77 | 59 | 28 |
| Apr. | 30 | 22 | 86 | 72 | 18 | 25 | 14 | 77 | 57 | 24 |
| May | 29 | 22 | 84 | 72 | 14 | 24 | 13 | 75 | 55 | 15 |
| June | 29 | 21 | 84 | 70 | 2 | 24 | 13 | 75 | 55 | 8 |
| July | 29 | 22 | 84 | 72 | 9 | 24 | 13 | 75 | 55 | 19 |
| Aug. | 30 | 22 | 86 | 72 | 5 | 25 | 12 | 77 | 54 | 15 |
| Sept. | 31 | 23 | 88 | 73 | 12 | 26 | 13 | 79 | 55 | 20 |
| Oct. | 32 | 23 | 90 | 73 | 11 | 25 | 14 | 77 | 57 | 19 |
| Nov. | 33 | 23 | 91 | 73 | 6 | 25 | 13 | 77 | 55 | 16 |
| Dec. | 32 | 23 | 90 | 73 | 14 | 26 | 14 | 79 | 57 | 19 |



Many of the insects in Papua New Guinea, such as flies, malarial mosquitoes, and mites that carry scrub typhus, endanger the health of people visiting the country. Others include some of the world's most beautiful butterflies and moths. Butterfly farms have been set up to cultivate butterflies that are unique to Papua New Guinea, including some of the large "birdwings." The butterflies are then sold to collectors.

## Economy

The basic unit of currency in Papua New Guinea is the *kina*. It is divided into 100 *toea*. Both are the names of traditional shell money. Kina shells are worn half moons cut from the goldlip pearl shell. They were worn on ceremonial occasions. The 20-kina note has a picture of a pig, the most valuable village animal.

Cash plays an increasingly important part in the lives of the people of Papua New Guinea as they leave their villages for the towns, take paid jobs on plantations, or sell some of their crops for cash. People living in villages use money to buy items at local shops and to pay taxes, school fees, and transport fares into town. They still continue to grow enough food in their gardens and obtain sufficient food through hunting to support themselves as they have always done. But the increasing use of money has been a powerful force in social change in Papua New Guinea.

**Farming and forestry.** Nearly all the people in Papua New Guinea are farmers who grow their own food and obtain other goods they need from the forests. In most areas, the farmers cultivate a plot of land until it loses fertility. They then clear and use other plots until the fertility of the first plot is restored. This type of farming is known as *shifting agriculture*. In the more fertile lowland areas and on the smaller islands, the main crops are taro, bananas, yams, breadfruit, and coconuts. In poorly drained areas, the starchy pith of the sago palm provides the bulk of the diet. In the highlands of the mainland, in New Ireland, and in Bougainville, the sweet potato is the main crop. Bananas and taro are important secondary crops. Almost all the people of Papua New Guinea breed pigs, which are regarded as a symbol of wealth rather than a food supply. The pigs are eaten only at feasts connected with special ceremonies.

About 40,000 people in Papua New Guinea grow coconuts. They produce about 100,000 metric tons of copra a year, both in large plantations and in small village farms. New Britain, New Ireland, Bougainville, and Madang districts, the main areas producing copra, also grow cocoa. Cocoa is also an important crop in the northern district. Of the total output of 30,000 metric tons of cocoa beans a year, more and more comes from small-scale farms.

Nearly all the coffee plantations lie in the highlands, where Arabica coffee beans are grown. A smaller amount of coffee is grown in coastal areas. But most of the 50,000 metric tons of coffee produced every year comes from the village farmers. Other crops yielding cash incomes for villages include tea, oil palm, pyrethrum, peanuts, tobacco, chili, cardamom, and fruits and vegetables. The tea is grown in the highlands for export. The oil palm is grown at large centres at Biala and Kimbe, in west New Britain, and at Higaturu, in the north in Oro Province. Rubber, an important plantation crop in the wet highlands inland from Port Moresby, is also being developed at Cape Rodney, west of Port Moresby.

Papua New Guinea nationals operate most of the cattle farms. Beef cattle are grazed in most of the provinces, because beef has become a popular food. Farmers also keep dairy cattle and pigs.

**Agriculture** includes coffee growing, which is an important industry around Goroka and in other highland districts.

**Markets,** such as Koki Market in Port Moresby, enable villagers to sell their produce to people who live in cities.

Surveys show that Papua New Guinea has about 4.4 million hectares of forest with a high potential for logging. About 8 million hectares have possible potential. A further 24 million hectares are in rough and mountainous country where logging would be severely limited. Almost 5,000 people work in the timber industry, 97 per cent of them Papua New Guineans. They provide timber for logs, sawed timber, plywood, veneers, and wood chips for export to Australia, New Zealand, Asia, and Europe.

Fishing is an important industry in Papua New Guinea. Many valuable fish—especially the skipjack tuna—thrive within the country's 320-kilometre economic zone.

**Mining.** Production of gold is on the increase as it becomes more scarce in other parts of the world and as its value rises. Small deposits of other minerals, including lead, iron, nickel, chrome, manganese, and low-grade coal, have been reported. But none have been of commercial interest. Petroleum and natural gas exploration has resulted in the discovery of seven gasfields in the Gulf district. Two of them are offshore fields in the Gulf of Papua.

In 1972, the newly developed mine of the Bougainville Copper Industries Company at Panguna came into production after an outlay of nearly 500 million Australian dollars on development work. It is one of the largest copper mines in the world, with a yearly production of about 175,000 metric tons of copper. Gold produced from the copper concentrate is worth as much as the copper. The copper concentrate is exported to Japan, Germany, and Spain. In 1984, gold production began at Ok Tedi in the remote Star Mountains of the New Guinea island, close to the Indonesian border.

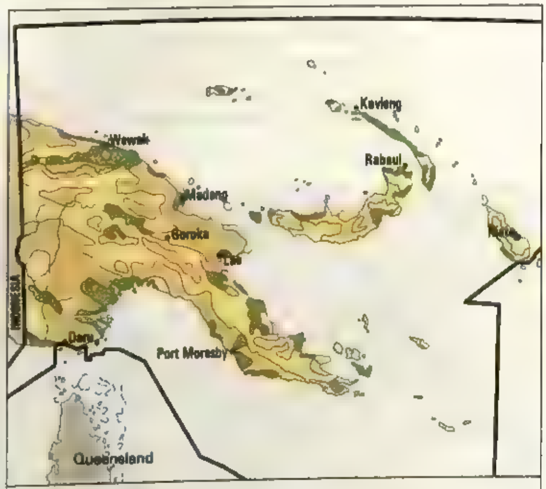
**Manufacturing** in Papua New Guinea includes mainly the processing of farm, forest, and fish products for export. Factories also produce consumer goods for the local market. There are over 700 factories employing nearly 25,000 workers. The largest group is concerned with machines and vehicles, particularly maintenance and repair work on them. The second largest group includes industries connected with timber, such as sawmills, plywood mills, and joinery works. Most of their products are exported. The third group is concerned with processing farm products for export as well as making food, drinks, and tobacco goods for local use. There is also a mixed group that involves cement goods, clothing, furniture, paints, printing, and chemicals for local use. The main centres of manufacturing are Port Moresby, Lae, Rabaul, Madang, Goroka, Bulolo, and Panguna-Arawa and Kieta on Bougainville.

**Trade.** The value of imports each year is about double that of all exports excluding copper. Copper concentrates alone are nearly equal to the imports. Major exports are copper concentrates, cocoa, copra, coffee, palm oil, timber and timber products, rubber, tea, fish, crayfish, and prawns. Imports include machines and vehicles, food, petroleum products, chemicals, and manufactured goods.

**Transport and communications.** There are more than 400 airfields scattered throughout Papua New Guinea. The national airline, Air Niugini, flies to Sydney, Brisbane, and Cairns in Australia; Jayapura in Indonesia; Honiara in the Solomon Islands; Manila in the Philippines; and Singapore. The airline also operates flights between most domestic provincial centres.

Almost all towns are linked by subscriber trunk-dialling telephones, powered by a solar energy system. There is a direct-dialling service to Australia and a num-

**Mining** is dominated by the enormously rich deposits of copper at Panguna on the island of Bougainville.




**Papua New Guinea land use**

**A British protectorate,** proclaimed in 1884, was the first national government over the area that became Papua.

ber of other countries. Rural areas are linked by high-frequency radio, or very high frequency telephones. The National Broadcasting Commission of Papua New Guinea controls all broadcasting services in the country. Programmes of both general and local character are provided from Port Moresby, Lae, Daru, Alotau, Kerema, Madang, Mount Hagen, Wewak, Rabaul, Kieta, Mendi, Lorengau, Popondetta, Kimbe, Kundiawa, Kavieng, Goroka, Vanimo, and Wabag. Television was introduced in Papua New Guinea in 1987.

### History

**Prehistory.** Not much is known about the origins of the people of Papua New Guinea. The little evidence available suggests that people have been living in Papua New Guinea for at least 27,000 years. They used stone tools to fashion wooden spears for hunting. At some time, they learned to cultivate plants. When the sweet potato was introduced to Papua New Guinea, people could grow enough food to support a large population. They have been living in the highlands for at least 10,000 years. Possibly about 3,000 years ago, people from the mainland coasts and islands districts began to move out from New Guinea to settle in other Pacific Islands. This migration continued for perhaps 2,000 years.

**European intrusion.** Europeans first made contact with New Guinea in 1526. But they did not make permanent settlements there until the 1870's.

From 1526 to 1607, there were five separate contacts. In 1526, Jorge de Meneses, a Portuguese, gave the land the name *Papua,* a Malay term meaning *fuzzy-haired man.* The name *Nova Guinea* was given by Ortiz de Retes, another Portuguese, in 1545. Luis Vaez de Torres, a Spanish navigator, sailed along the entire south coast of the mainland in 1606 and 1607.

The Dutch established themselves in the Indonesian Archipelago. They were disappointed to find no riches in New Guinea, but they took possession of the western part to stop the British and the French from claiming it. William Dampier, an Englishman, named New Britain and navigated Dampier Strait. Another Englishman, Phillip Carteret, navigated St. George's Channel. After 1788, these areas were on shipping routes between Sydney and Canton and Java. The people had regular contact with Europeans such as traders and whalers who put in for food and water. The French explorers Louis de Bougainville, Jean François de Surville, and Bruni D'Entrecasteaux navigated the dangerous waters of eastern New Guinea and named many of the islands and ports. John Moresby charted the southern and north-eastern coasts for the British navy.

**Permanent European settlement.** In the last quarter of the 1800's, European traders, planters, scientists, and missionaries began to settle in Papua New Guinea. Australian bêche-de-mer traders operated around the Gulf of Papua. Germans traded bêche-de-mer, trochus shell, and coconuts in the Bismarck Archipelago. Some bought land and grew copra on the Duke of York Islands and the Gazelle Peninsula. The Russian scientist Nicolaus Mikluho-Maclay spent several years on the Maclay Coast. The Italian scientist Luigi D'Albertis explored the Fly River.

**Self-government** developed slowly through the work of the House of Assembly between 1964 and 1973. The country became independent in 1975.

**European annexation.** In 1884, Germany annexed northeastern New Guinea and the islands off its shore. Powers of administration in the colony were assigned to the Neu-Guinea Kompagnie. In November of the same year, the United Kingdom (UK) government proclaimed a protectorate over what is now Papua.

The territory annexed by Germany was known as *German New Guinea* until the defeat of Germany in World War I (1914-1918). It then became a mandated territory of Australia. The territory annexed by the UK was known as *British New Guinea* until 1906, when Australia took over full responsibility for it.

**German New Guinea, 1885-1921.** The Imperial Charter of May 17, 1885, officially granted royal authority in the colony to the Neu-Guinea Kompagnie. However, lack of financial success forced the company to give up its sovereign rights. On April 1, 1899, the Imperial German Government took over administration.

When World War I broke out in 1914, the UK government ordered an Australian naval and army force to occupy German New Guinea. An Australian military force remained in control there until 1921.

**The mandated Territory of New Guinea, 1921-1942.** After the war, the League of Nations conferred on Australia a mandate for the government of the Territory of New Guinea. The government took over German property and auctioned it.

Gold discoveries in the Bulolo River and at Edie Creek in the late 1920's helped the New Guinea economy. The search for gold led to the exploration of the highlands and the discovery of the many people living there.

**Papua, 1906-1942.** Sir Hubert Murray was lieutenant governor of Papua from 1908 until his death in 1940. During his long term of office, Murray had the territory almost completely explored in a peaceful fashion. The most dramatic expedition was the crossing of the mainland from the Fly River to the Sepik River in 1928 by patrol officers Karius and Champion.

**World War II.** On Jan. 4, 1942, Japanese planes bombed Rabaul. Seventeen days later, 3,000 Japanese troops invaded Rabaul. The Japanese fleet was finally destroyed in the Battle of the Coral Sea and the Japanese troops were turned back on the Kokoda Trail.

**Reconstruction, 1945-1951.** Australian involvement with Papuans and New Guineans during the war led to new thinking about labour questions and social welfare. The United Nations accepted the terms Australia proposed for a trusteeship agreement, and New Guinea came under the international trusteeship system. The Papua-New Guinea Provisional Administration Act came into force in 1945. It restored civil administration to Papua and New Guinea and combined the two territories under one administration with its headquarters in Port Moresby. In 1949, Australia decided to set up a Legislative Council, an Executive Council, a system of local government, and a judicial system for Papua New Guinea. It also began a programme to develop education, social welfare, and agriculture.

**Bougainville.** In 1988, landowners and armed militants, the Bougainville Revolutionary Army (BRA), demanded Bougainville's political independence and the closure of the copper mine at Panguna, which they claimed had caused significant environmental damage. After a violent outbreak, the island claimed independence and the mine was closed. By 1993, government troops had regained 80 per cent of the province.

**Political growth.** A Legislative Council of appointed members was set up in 1951. The first House of Assembly elections in which all adults could vote were held in 1964. There were 38 Papua New Guineans in this house. In the second House of Assembly of 1968, the ethnic qualifications for the old special electorates were eliminated and regional electorates replaced them. There were 65 Papua New Guineans in this house.

In 1971, a new arrangement of electoral boundaries increased the number of elected members to 100. In the 1972 elections, political parties played a major part for the first time. No party emerged with an absolute majority. The Pangu Party formed a government through a coalition with the People's Progress Party and the National Party. Its leader, Michael Somare, became chief minister. Papua New Guinea achieved self-government in December 1973, and full independence in 1975. Michael Somare became the country's first prime minister in 1975 and again in 1977. He lost a vote of confidence in 1980 and was succeeded by Sir Julius Chan. But Somare returned to power at the 1982 election. In 1985, Somare again lost a vote of confidence and was succeeded by the country's first highlands prime minister, Paias Wingti. In 1988, Rabbie Namaliu became prime minister. In 1992, Wingti was elected for a second term. In 1994, Sir Julius Chan was again elected prime minister.

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|---|---|---|
| Chan, Sir Julius | New Guinea | Somare, Michael |
| Chimbus | Pidgin | Tolais |
| Kukukukus | Port Moresby | Wingti, Paias |
| Mekeos | | |

**Outline**

| | |
|---|---|
| **I. Government** | |
| A. Law and order | B. Social services |
| **II. People** | |
| A. Population and ancestry | D. Religion |
| B. Way of life | E. Art |
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| **III. Education** | |
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| A. European influences | C. Making a modern nation |
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| A. Location and size | D. Climate |
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| **VI. Economy** | |
| A. Farming and forestry | D. Trade |
| B. Mining | E. Transport and communications |
| C. Manufacturing | |
| **VII. History** | |

**Questions**

When did Europeans first make contact with New Guinea?
What are *haus tamburan*?
What is Papua New Guinea's most important single source of wealth?
What are *goannas*?
For what purpose was a schools' curriculum unit set up in 1975?
What is the most widely spoken language in Papua New Guinea?
Who was Papua New Guinea's first prime minister?
What is the significance of *bride price*?
What are the obstacles to the production of hydroelectricity in Papua New Guinea?
What environmental factors have kept groups of people separate in Papua New Guinea?

**Papyrus** is a reedlike water plant that grows in Egypt. Ancient Egyptians used papyrus fibres as a writing material.

**Papyrus** is an Egyptian water plant. Its fibres were used by the Ancient Egyptians as a writing material. It served also as a material for mats, sandals, and sailcloth for small boats. The brownish flowers were made into garlands for the shrines of the Egyptian gods. Many people think the little ark in which the mother of Moses hid her son was made of papyrus. Some scholars believe that different species of papyrus were used for these purposes, and that all of these species were called by one name.

The plant still grows in the valley of the Upper Nile in Egypt. Its reedlike stems grow to between about 1 to 3 metres high and bear no foliage. The coarse leaves spring directly from the rootstock. Bristles surround the flowers.

The papyrus of the Ancient Egyptians was made of strips of the stem. They were laid in layers, and then placed under pressure. The crushed strips matted into a loose-textured, porous, white paper. Time has turned surviving papyrus manuscripts brown and has made them brittle. Papyrus first appeared in the shape of long, rectangular sheets in different sizes. The sheets were at first rolled and tied with a string. Later they were bound together like modern books.

Until the 100's B.C., Egypt guarded the monopoly of preparing the paper. Then papyrus was gradually replaced by the more durable parchment, produced from animal skin.

**Scientific classification.** The papyrus plant belongs to the sedge family, Cyperaceae. It is classified as *Cyperus papyrus.*

See also **Paper** (History); **Scroll.**

**Pará nut.** See **Brazil nut.**

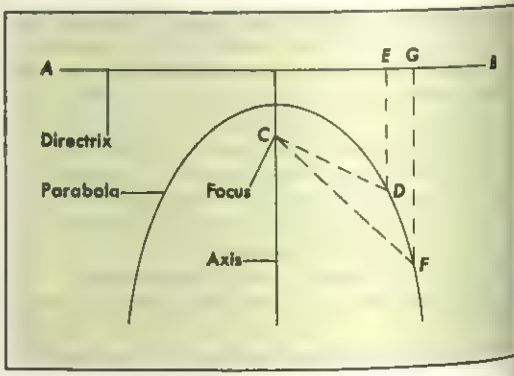
**Parable** is a brief story, proverb, or saying that expresses a moral. Most parables illustrate difficult or mysterious ideas through situations that can be easily understood.

Almost all parables express religious ideas, and the Bible includes many such stories. For example, the Old Testament contains a parable told by Nathan to King David. A rich man had many sheep, but a poor man had only one. The rich man wanted to feed a traveller who called at his door. To do so, he killed the poor man's only sheep, rather than take one from his own flock. Nathan was actually comparing the rich man with David, who had married another man's wife (II Sam. 12: 1-7).

The best-known parables are those of Jesus Christ in the New Testament. Jesus used simple, everyday situations to express such ideas as the Kingdom of God, the proper use of wealth, and the nature of prayer. For example, he compared Judgment Day to a fisherman's net cast into the sea (Matt: 13: 47-50). The net caught all kinds of fish. But after it was pulled to shore, the edible fish were kept and the bad-tasting ones were thrown away. Jesus was saying that on Judgment Day, people who have been saved from damnation will likewise be separated from the damned.

**Parabola** is one of the curves most used in science. The path of a cricket ball hit high is nearly a parabola. Any point on a parabola is the same distance from a line *AB* as it is from a point *C*. Line *AB* is the *directrix* and point *C* is the *focus.* The solid line through point *C*, which bisects the parabola, is called the *axis.*

A parabola revolved about its axis generates a *parabolic surface.* A light at the focus of a mirror with this shape would cause the light rays that hit the mirror to reflect parallel to the axis. Scientists use this principle of the parabolic surface in producing headlight and searchlight reflectors.




**A parabola** is a curve drawn on a plane. The diagram above shows that any point on a parabola is the same distance from the directrix, line *AB*, as it is from the focus, point *C*. Therefore, *CD* equals *DE*, and *CF* equals *FG*.

**Paracelsus, Philippus Aureolus** (1493?-1541) was a Swiss doctor who introduced the use of drugs made from minerals. His drugs included such minerals as sulphur, mercury, and antimony. Paracelsus challenged the ancient Greek and Roman belief that disease is caused by an imbalance of body *humours* (fluids). He argued that each illness has a specific, external cause.

Paracelsus was the first doctor to treat disease with moderate doses of minerals that had been *detoxified*—that is, that had had their poisons removed. He also became the first doctor to correctly describe chorea, silicosis, congenital syphilis, and tuberculosis.

Many of Paracelsus' theories were criticized, however, because they were based in part on unscientific principles associated with alchemy, astrology, and mysticism (see **Alchemy**). Paracelsus argued that disease is

caused by external factors that take possession of part of the body. But he also believed that spiritual forces were among the causes of disease and that he, as a spiritualist, could control them with the use of minerals and herbs.

Paracelsus was born in Einsiedeln, Switzerland. His full name was Theophrastus Bombastus von Hohenheim. He received his early education from his father, a doctor.

**Paracetamol** is a commonly used drug that relieves pain and reduces fever. Many people take paracetamol instead of aspirin because they are allergic to aspirin, have stomach ailments, or use *anticoagulants* (substances that prevent or slow blood clotting). Paracetamol, unlike aspirin, does not irritate the stomach or interfere with blood clotting. However, paracetamol cannot reduce inflammation nearly as well as aspirin. Therefore, it is not as useful in treating inflammatory conditions, such as arthritis or rheumatic fever.

Paracetamol can be purchased without a prescription under many trade names. It seldom causes side effects when taken in normal doses. A heavy overdose can lead to liver damage, which may be fatal.

Paracetamol was first used in medicine in 1893. However, it gained widespread use only after 1949, when scientists discovered that another popular drug, *phenacetin,* is converted to paracetamol in the body. Paracetamol proved to be as effective as phenacetin but less toxic.

**Parachute** is a device used to slow the fall of a person or object from an aircraft or any other great height. The operation of a parachute is based on simple principles. There are two forces that act on any falling object—gravity and air resistance. Gravity pulls the object toward the earth. But air resists the object's movement. Because the pull of gravity is much stronger than the resistance of the air, the air can only slow the speed of the falling object. Large surfaces offer the greatest resistance to the air. Thus, the larger the parachute's surface, the more air resistance it meets and the slower it falls.

**Uses of parachutes.** One of the early uses of parachutes was to allow descent from gas-filled balloons. Since the development of aeroplanes, parachutes have been used for emergency jumps from damaged aircraft. They have also been used to deliver cargo. Aeroplanes drop food and medicine by parachute to places that cannot be reached easily by other means. Special military uses for parachutes were developed during the 1930's. Both the Allies and Germans used *paratroops,* or parachute troops, during World War II (1939-1945). Some aeroplanes use parachutes as brakes when landing. Parachutes are also used to recover the booster rockets from spacecraft that have been launched into the atmosphere. Today, most parachutes are used for sport jumping, called *skydiving.*

**Parts of a parachute.** The part of the parachute that catches the air is called the *canopy.* For many years, parachutes had a round canopy that looked somewhat like an umbrella. Today, most canopies have a rectangular shape, somewhat like the wing of an aeroplane. The front part of a rectangular canopy is cut off, allowing air to enter. The air inflates the canopy and makes it fairly rigid, like an air mattress.

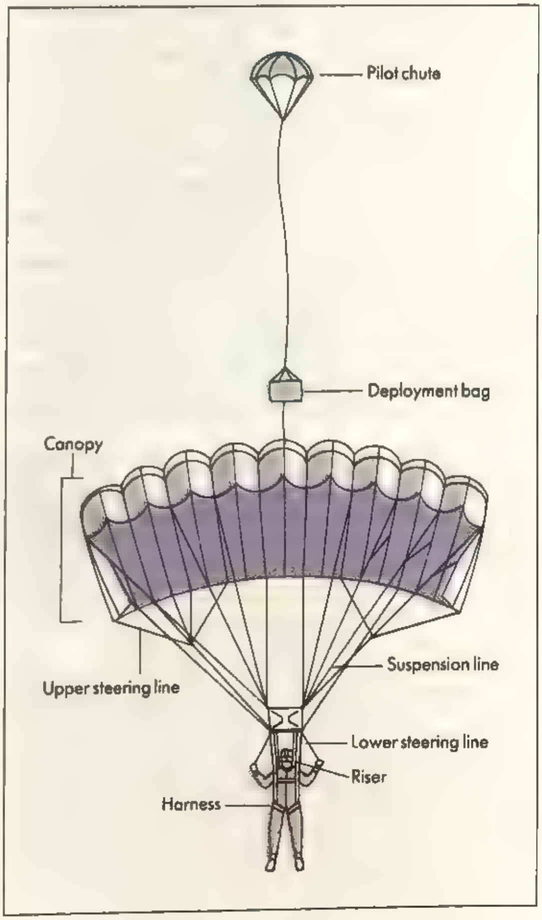
Skydivers generally use a rectangular parachute that is twice as long as it is wide. Many sport parachutes measure 3.4 by 6.8 metres. Round parachutes, which today are used mainly for cargo, may measure up to 30 metres across. Parachute canopies were once made of silk. But nylon, which is stronger and cheaper, has been used since the early 1940's.

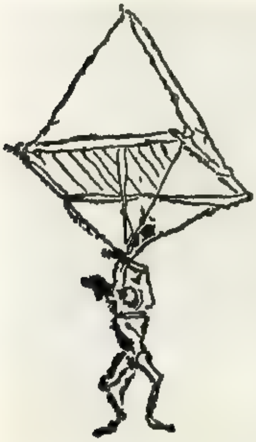
The canopy is packed in a container made of heavy nylon cloth. Special pins called *ripcord pins* hold the container shut. The container is attached to the parachutist's body by a *harness* that fits around the shoulders and legs. Straps called *risers* connect the harness to *suspension lines,* which attach to the canopy. Skydivers wear a main parachute and a reserve parachute for emergencies. The reserve parachute is usually mounted on the back, just above the main parachute.

**How parachutes work.** Skydivers generally open their parachutes at about 750 metres. The parachutist reaches into a pouch on the leg strap and pulls out a pilot parachute that measures about 0.9 metre across. This parachute quickly inflates, releases the ripcord pin on the container, and pulls out the canopy. If the main parachute fails, there is still time to activate the reserve

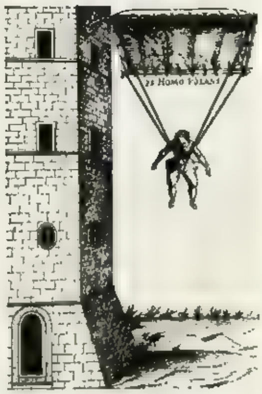
**Parts of a parachute**

A sport parachute brings a skydiver down very slowly. When the skydiver pulls the ripcord, the pilot chute opens and pulls out the canopy, which unfolds in a few seconds.





**Leonardo da Vinci** drew a sketch, *left*, of a parachute he designed in 1495. He called it a "tent roof."



**An early parachute** illustration, *right*, was made in 1617 to accompany an article by an Italian experimenter.

parachute. After the canopy opens, the ride to the ground takes about 3 minutes. The parachute moves at about 32 kilometres per hour. The parachutist can pull on the steering lines to turn right or left.

Rectangular parachutes have a greater forward speed than round parachutes and so are not easily blown backward when they encounter wind. Rectangular parachutes also descend more slowly than round parachutes. In landing, the parachutist can pull down the back edge of a rectangular canopy. This slows the parachute's motion and permits a gradual, soft landing.

**History.** In the 1100's, the Chinese may have experimented with parachutes by jumping from high structures with rigid umbrellalike devices. The first known parachute jump was made from a tower in 1783 by the French physicist Sebastian Lenormand. The first parachute jump from a balloon was made in 1797, and the first freefall parachute jump from a damaged aeroplane in 1922.

See also **Air** (picture); **Airborne troops; Skydiving.**

**Parade** is a public march or procession honouring a particular occasion. The mood of a parade may vary from joyous excitement to solemn dignity. Members of the armed forces often parade on holidays to show off their strength, condition, equipment, and skill. Many parades are colourful events with floats, band music, brightly dressed marchers, and trained animals.

Parades in the form of religious processions go back to about 3000 B.C. Ancient cities often had special, elaborately constructed streets whose main function was to provide a place for processions. The Romans enjoyed parades, especially the processions of the performers at the circus. They also had frequent military parades, called *triumphs,* during the time of the empire (see **Triumph**). Parades to honour particular feasts became popular in the early Christian church, and remain so today. Political parades are popular in many countries.

**Paradise** is a name for heaven. It was originally a Persian word used for the amusement parks of Persian kings. The Greeks borrowed the word from the Persians. Greek translators of the Bible used the word paradise in reference to the Garden of Eden (Gen. 2-3). Jewish authors after 200 B.C. saw paradise as a place of reward after death. Early Christian writers used the term in the same sense. For example, in the Gospel of Luke, Jesus is reported as promising paradise to a thief dying on the cross. See also **Heaven.**

**Paraffin** is an important petroleum product, used chiefly as fuel. At one time, paraffin lamps were the chief source of artificial lighting. In the petroleum industry, the product is sometimes called *kerosine.* It is called *kerosene* in North America, or when used as a fuel for aircraft engines. See **Kerosene.**

Abraham Gesner, a Canadian doctor and geologist, patented a distilling process for refining oil in 1854. He produced an improved lighting oil which he called *kerosene.* He refined the oil from coal, and for this reason it was also called *coal oil.*

**Production.** Paraffin is a product of petroleum refinery processes. Industry processes paraffin to remove impurities such as sulphur compounds and some of the aromatic hydrocarbons. The paraffin is treated with a suitable solvent like liquid sulphur dioxide, which dissolves some of the impurities.

**Properties.** Paraffin is a mixture of *hydrocarbons,* compounds containing the elements hydrogen and carbon. This mixture boils between 150 and 300° C. The specific gravity, or density, of paraffin is about 0.8. Some of the compounds in paraffin are *aromatic* hydrocarbons. Paraffin is used as a fuel and also as a solvent for weed killers and insecticides. See **Hydrocarbon.**

See also **Rocket** (Rocket propellant).

**Paraffin wax** is a white, partly clear, waxy solid that has no odour or taste. Paraffin wax forms a moisture-proof film, and is used to make waterproof cardboard containers such as milk cartons. It is also the major ingredient in candles.

Paraffin wax is made from a mixture of high-boiling petroleum *fractions* (products separated from petroleum). The petroleum fractions are chilled and pressed through a filter to remove heavy oil. The remaining solid is paraffin wax.

Ordinary paraffin wax melts at 32° to 66° C. *Microcrystalline wax* is composed of larger *hydrocarbons* (substances containing hydrogen and carbon) than ordinary wax. It melts at 66° to 85° C.

**Paragraph** is a section of a written work that consists of one or more sentences constructed and arranged to function as a unit. The first line is normally indented. The subject or topic of a paragraph is often stated in the first sentence, called a *topic sentence.* Paragraphs may range in length from a single word used for emphasis, such as "Never!," to several hundred words. But most paragraphs are from 100 to 200 words long.

An effective paragraph must be unified, ordered, and complete. A paragraph is unified when all the sentences contribute to creating a single idea. A paragraph has order when the sentences form a pattern, such as leading from cause to effect or from the particular to the general. A paragraph is complete when the writer brings its idea clearly into focus.

**The skyline of Asunción,** Paraguay's capital and largest city, consists of modern high-rises and traditional Spanish-style buildings. About a fifth of all Paraguayans live in or near Asunción.

# Paraguay

**Paraguay,** a small landlocked country located near the centre of South America, is surrounded by three countries—Argentina, Bolivia, and Brazil. The Paraguay River flows through Paraguay from north to south and divides the country into two sharply different land regions. West of the river lies the Chaco, a flat, thinly settled area of coarse grasses, scrub forests, and salt marshes. Eastern Paraguay, on the other hand, has rolling hills, fertile soil, and thick forests.

The great majority of the Paraguayan people live in the eastern part of the country. About a fifth of them live in or near Asunción, the capital and largest city. Almost all Paraguayans are of mixed Guaraní Indian and Spanish ancestry. The Guaraní Indians were the original inhabitants of what is now Paraguay. They intermarried with Spanish settlers, who began to arrive in the 1500's. Most Paraguayans speak both Guaraní and Spanish. Nearly all the people are Roman Catholics.

Paraguay is a poor country whose economy is based chiefly on agriculture and forestry. About half the people of Paraguay live in rural areas, and most of them make a bare living farming. The country's most valuable resources are fertile soil, dense forests, and vast hydroelectric power potential—all of which could provide for strong economic growth if they were more fully developed.

Spain ruled Paraguay until 1811, when Paraguay declared its independence. Over the years, the country has suffered from terrible wars with neighbouring nations and from struggles for power among rival political groups.

## Government

**National government.** Paraguay's Constitution, adopted in 1992, provides for a democratic form of government. Under the Constitution, voters elect the president, Paraguay's head of government, to a five-year term. The president may not be reelected.

The president appoints a cabinet called the Council of Ministers. The cabinet members head the government departments and assist the president in carrying out the operations of Paraguay's government.

### Facts in brief about Paraguay

**Capital:** Asunción.
**Official languages:** Spanish and Guaraní.
**Official name:** República del Paraguay (Republic of Paraguay).
**Area:** 406,752 km². *Greatest distances*—north-south, 925 km; east-west, 660 km.
**Elevation:** *Highest*—680 m above sea level, near Villarrica. *Lowest*—55 m, at the meeting point of the Paraguay and Paraná rivers.
**Population:** *Estimated 1996 population*—4,576,000; density, 11 people per km²; distribution, 51 per cent rural, 49 per cent urban. *1992 census*—4,123,550. *Estimated 2001 population*—5,164,000.
**Chief products:** *Agriculture and forestry*—livestock, timber trees, cotton, soybeans, wool, cassava, sugar cane, maize, tobacco, rice. *Manufacturing*—processed foods and beverages; wood products, textiles, cement, leather goods.
**National anthem:** "¡Paraguayos, república o muerte!" ("Paraguayans, Republic or Death!").
**Money:** *Currency unit*—guaraní. One guaraní = 100 centimos.

Paraguay's legislature, called the National Congress, consists of a 45-member Senate and an 80-member Chamber of Deputies. Voters elect the members to five-year terms.

**Local government.** Paraguay is divided into 17 departments for the purposes of local government. Voters elect a governor to be the head of each department. The departments are subdivided into smaller units of government.

**Politics.** The National Republican Association, popularly called the Colorado Party, is Paraguay's largest single political party. It dominated the country's politics from 1947 to 1993, when the first democratic, multiparty elections were held. The Authentic Radical Liberal Party is second in size, and the National Encounter party is third. The law requires all citizens of Paraguay 18 years of age and older to vote.

**Courts.** The Supreme Court of Justice is Paraguay's highest court. It has nine justices. The justices are appointed by the Senate from candidates that are proposed by a council of government representatives, lawyers, and law professors. The Supreme Court justices serve until age 75.

**Armed forces.** Paraguay's armed forces have about 17,000 men. Men are conscripted at age 18 and serve one year.

## People

**Population and ancestry.** For Paraguay's total population, see the *Facts in brief* table with this article. More than 95 per cent of the people live in the eastern part of the country. The rest live in the west, or the Chaco, where poor soil, an arid climate, and a lack of roads have discouraged settlement.

The Guaraní Indians lived in what is now Paraguay long before the first Spanish settlers arrived in the 1500's. Over the years, many Indians and Spaniards intermarried. Today, about 95 per cent of all Paraguayans are *mestizos* (people of mixed white and Indian ancestry). A small number of people of unmixed Indian ancestry live in the Chaco. People of Chinese, German, Korean, and Japanese descent also make up a minority.

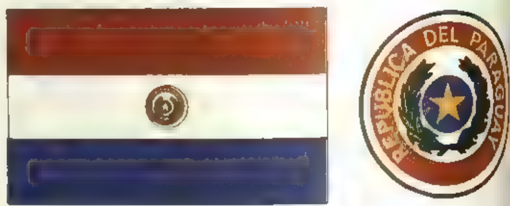
**Languages.** Paraguay has two official languages —Spanish and Guaraní. Spanish is used in the schools, in government, and in commerce. But people throughout Paraguay generally use Guaraní in everyday conversation. Books, newspapers, and magazines are published in both languages.

**Way of life.** Paraguay has a large lower class, which consists of nearly all rural people and most city dwellers. Middle-class Paraguayans, most of whom live in urban areas, form a small but growing portion of the population. The nation's tiny upper class consists chiefly of government officials, military leaders, and wealthy landowners and business people.

*Rural life.* About half of all Paraguayans live in rural areas. Most of them are farmers who grow food mainly for their own families. Other rural Paraguayans work on cattle ranches, on large farms that produce crops for export, in forestry, or in small factories that process farm or forest products.

Most rural Paraguayans live in one-room houses called *ranchos.* Most ranchos have earthen floors; reed, wood, or brick walls; and a thatch roof sloped to carry

**A Paraguayan lacemaker** carefully creates a complicated flower pattern in a piece of ñandutí lace. The making of ñandutí lace is a tradition begun by Paraguay's Guaraní Indians.




**Symbols of Paraguay.** Paraguay's flag has the coat of arms on the front, *left,* and the Treasury seal on the back. It is the only national flag with a different design on each side. The star on the coat of arms, *right,* stands for independence from Spain.


**Paraguay** lies near the centre of South America. It is surrounded by Argentina, Bolivia, and Brazil.

off heavy rains. A separate or attached shed serves as a kitchen. Few houses have indoor plumbing.

*City life.* About half the people of Paraguay live in cities and towns. Asunción, the capital, is the largest city by far. It has about half a million people. Other major cities include Ciudad del Este, Fernando de la Mora, Lambaré, and San Lorenzo. City dwellers include craftworkers, unskilled labourers, factory workers, government employees, office workers, shopkeepers, and professional people. In general, urban Paraguayans have a higher standard of living than people in rural areas. The cities have better schools, more medical facilities and other services, and a variety of cultural and recreational activities.

Many city people live in small, pastel-coloured houses of brick or stucco. The houses have tile roofs, and iron grillwork covers the windows. The poorest people live in shacks built of scraps of wood or metal. Unlike many other large Latin-American cities, Asunción does not have sprawling slum areas.

**Clothing.** Urban Paraguayans dress as people do in Europe and the United States. Many rural women wear a shawl, called a *rebozo,* and a simple dress or a skirt and blouse. Rural men generally wear loose trousers, called *bombachas,* a shirt or jacket, a neckerchief, and a poncho. Most rural Paraguayans go barefoot.

**Food and drink.** Paraguayans eat much meat, especially beef. Beef is often cooked with vegetables in a stew called *puchero.* Another common food is *cassava,* a starchy root vegetable. Cassava may be boiled or ground into flour and made into a kind of bread called *chipá. Sopa paraguaya,* often served on special occasions, consists of maize cooked with eggs, milk, onions, and cheese. The favourite beverage is a tea called *yerba maté* or simply *maté.* It is made from the leaves of a holly tree that grows in the eastern forests.


## Paraguay map index

### Cities

| | | | |
|---|---|---|---|
| Areguá* | 5,030 | D | 3 |
| Asunción | 457,210 | D | 3 |
| Caacupé | 10,280 | D | 4 |
| Caaguazú | 19,450 | D | 4 |
| Ciudad del Este | 49,160 | D | 5 |
| Concepción | 22,590 | C | 3 |
| Coronel Bogado | 5,180 | E | 4 |
| Encarnación | 29,960 | E | 4 |
| Fernando de la Mora* | 66,450 | D | 3 |
| Hernandarias | 11,140 | D | 5 |
| Horqueta | 4,450 | C | 4 |
| Itá | 9,170 | D | 3 |
| Itauguá* | 5,400 | D | 3 |
| Lambaré | 67,180 | D | 3 |
| Luque | 25,070 | D | 3 |
| Mariscal Estigarribia | 6,220 | B | 2 |
| Paraguarí | 5,640 | D | 4 |
| Pedro Juan Caballero | 37,340 | B | 4 |
| Pilar | 13,060 | E | [illegible] |
| Piribebuy* | 5,670 | D | [illegible] |
| Puerto Presidente Franco* | 12,570 | D | 5 |
| Rosario | 4,240 | D | [illegible] |
| Salto del Guaira | 6,650 | C | 5 |
| San Antonio* | 5,300 | D | 3 |
| San Estanislao | 5,900 | D | [illegible] |
| San Ignacio | 6,870 | E | 4 |
| San Juan Bautista | 7,400 | E | 4 |
| San Lorenzo | 74,240 | D | 3 |
| Santa Rosa | 4,070 | E | [illegible] |
| Tobatí | 5,740 | D | 4 |
| Villa Elisa* | 6,700 | D | 3 |
| Villa Hayes | 7,660 | D | 3 |
| Villarrica | 21,420 | D | 4 |
| Villeta* | 5,230 | D | 3 |
| Ybycuí | 4,000 | D | 4 |
| Ypacaraí* | 5,510 | D | 3 |

### Physical features

| | | |
|---|---|---|
| Acaray River | D | 5 |
| Alto Paraná River | E | 5 |
| Apa River | B | 4 |
| Aquidabán River | C | 4 |
| Aracanguy Mountains | D | 4 |
| Cerro Leon (mountain) | A | 2 |
| Gran Chaco (region) | B | 2 |
| Itaipu Dam | D | 5 |
| Jejui Guazú River | C | 4 |
| Monte Lindo River | C | 3 |
| Negro River | C | 3 |
| Paraná River | E | 3 |
| Paraguay River | E | 3 |
| Pilcomayo River | D | [illegible] |
| Tebicuary River | E | 3 |
| Verde River | C | 2 |

*Does not appear on map; key shows general location.
Source: 1982 census.

**Recreation.** Soccer is the favourite sport in Paraguay. The people also enjoy basketball, volleyball, horse racing, and swimming. Paraguayans celebrate religious holidays with festivals that often include music, dancing, parades, and athletic contests.

**Religion.** Over 90 per cent of the Paraguayan people are Roman Catholics. The Constitution makes Catholicism the state religion, but it guarantees freedom of worship. Protestants, many of whom are Mennonites, make up about 1 per cent of the population.

**Education.** More than 80 per cent of all Paraguayans over the age of 15 can read and write. The government provides free state schooling up to university level. Paraguay also has many private schools, which charge for tuition. The law requires children from the ages of 7 to 14 to attend school. But the law is not strictly enforced, especially in rural areas. Many rural children never attend school, or drop out to help their families farm the land. In addition, numerous rural areas have teacher shortages, and some have no schools at all. Paraguay has two universities—the National University of Asunción and the Catholic University. The Catholic University operates in Asunción, Villarrica, Concepción, Encarnación, and Pedro Juan Caballero.

**The arts.** Various Paraguayan arts show the influence of the Guaraní Indian culture. Popular music, for example, has a slow rhythm and is played in a sad minor key typical of traditional Guaraní music. Artists commonly portray Guaraní culture in their paintings. Craftworkers use Guaraní designs in producing fine pottery and handwoven baskets. Paraguay's most famous handicraft, however, is *ñandutí* lace, made by the women of the town of Itauguá. *Ñandutí* means *spider web* in Guaraní. The complicated patterns of ñandutí lace represent flowers, animals, and other familiar objects.

Spanish missionaries, who began to arrive in Paraguay in the 1500's, developed a written form of the Guaraní language. However, Guaraní was not used in literary works until the 1900's, and Guaraní literature today is little known outside Paraguay. Many Paraguayan literary works written in Spanish deal with events in the country's history.

## The land and climate

**Land regions.** The Paraguay River flows southwards through Paraguay. It divides the country into two major regions: (1) the Chaco, officially called Occidental Paraguay, and (2) Eastern Paraguay, officially called Oriental Paraguay.

***The Chaco*** stretches westwards from the Paraguay River. It is part of the Gran Chaco, a large region that extends into Argentina and Bolivia. The Chaco occupies about three-fifths of Paraguay but has less than 5 per cent of the country's population. Coarse grasses, scrub forests, and thorny shrubs cover much of the region. The Chaco also has scattered forests of quebracho trees and other hardwoods. Quebrachos are a source of *tannin,* a chemical used to process leather.

Several slow-moving rivers flow through the southern and eastern Chaco. The Pilcomayo River forms Paraguay's southwestern border with Argentina. The Pilcomayo and other rivers in the Chaco often overflow after heavy rains in the summer. Some of the rivers disappear during the winter dry season, and salt marshes form. In

**Rural Paraguayans** make up about half of the nation's population. Many of them, like these men taking a lunch break, work on large farms that produce crops for export.

much of the Chaco, the underground water is too salty for drinking or irrigation. Cattle ranches occupy parts of the region, mainly in the south. German-speaking people of the Mennonite faith have established several farming communities in the central Chaco, and scattered tribes of Guaraní Indians live in remote parts of the region. But most of the Chaco is uninhabited.

***Eastern Paraguay*** lies between the Paraguay River and the Paraná River. The Paraná forms part of Paraguay's border with Argentina and Brazil. The river flows through Argentina to the Atlantic Ocean. The Paraná thus provides Paraguay with an outlet to the sea. The heavily forested Paraná Plateau occupies the eastern third of the region. The rest of the region consists of low, grassy plains and forested hills.

More than 95 per cent of all Paraguayans live in Eastern Paraguay. Most of them live along the Paraguay River or in the southwestern part of the region, where small towns and farming villages dot the rolling countryside. Asunción lies on the Paraguay River, near the point where it meets the Pilcomayo River.

**Climate.** Most of Paraguay has a warm, humid climate. The Chaco is the hottest and driest part of the country, and the Paraná Plateau is the coolest and wettest. Paraguay lies south of the equator, and so its seasons are the opposite of those in the Northern Hemisphere. Temperatures in Asunción average 19° C in July and 29° C in January.

Eastern Paraguay receives about 125 to 165 centimetres of rain annually. The rain falls throughout the year in the region. The Chaco receives about 50 to 100 centimetres of rain yearly. It often has winter droughts and summer floods.

## Economy

Paraguay has a developing economy. Service industries and agriculture, including forestry, account for most of the nation's *gross domestic product* (GDP)—the total value of all goods and services produced in the country yearly. Many businesses and industries are pri-

vately owned. However, the national government plays a major role in economic planning and development. It also owns firms in such fields as banking, manufacturing, transport, and energy production.

**Service industries** account for about 55 per cent of Paraguay's GDP and employ about 45 per cent of the work force. Many of the workers are employed by government agencies; shops, restaurants, and hotels; banks; health care facilities; and schools. Others work in such fields as transport and communications.

**Agriculture and forestry** largely form the basis of Paraguay's economy. They account for about 30 per cent of the nation's GDP and employ about 45 per cent of all workers. Large cattle ranches cover parts of the Chaco and much of eastern Paraguay. Eastern Paraguay has the country's best soil. Farmers grow various crops, including cassava, cotton, maize, rice, soybeans, sugar cane, and tobacco.

Farms occupy only about a fifth of the land that could be used in Paraguay to grow crops. One reason is that many farmers do not grow much more food than they need for their families. In addition, the use of old-fashioned tools and methods keeps farmers from cultivating as much land as could be farmed. Many farmers do not own or even rent their land. Instead, they are *squatters* on public or private land. They work small plots until the soil is no longer productive, then move on to another area. Since the mid-1900's, government programmes have urged farmers to use modern tools and methods and to buy land in undeveloped areas.

Forests cover about half of Paraguay and are among the country's most valuable natural resources. Many kinds of trees are cut for timber. Quebracho trees, which grow mainly in the Chaco, are harvested for tannin, which is used to tan hides. Holly tree leaves are used to make yerba maté tea. Other valuable trees include cedars, coconut palms, and wild citrus trees.

**Manufacturing** accounts for about 15 per cent of Paraguay's GDP and employs about 10 per cent of its workers. The largest factories are in or near Asunción. Major manufactured goods include cement, leather goods, processed food and beverages, textiles, and wood products.

**Energy sources.** Hydroelectric power plants on the Acaray and Paraná rivers provide Paraguay with plentiful electricity. In addition, the country has enormous potential for further hydroelectric power development. The Itaipú Dam power plant, built by Paraguay and Brazil on the Paraná River, is one of the world's largest hydroelectric power projects. The plant began generating electricity in 1984 and was completed in 1991. Itaipú has the capacity to generate about 12½ million kilowatts of electricity.

**Trade.** Paraguay's chief exports include coffee, cotton, meat products, soybeans and other oilseeds, tannin, timber, tobacco, and vegetable oils. Its leading imports include chemicals, fuels and lubricants, iron and steel, machinery, and transportation equipment. Paraguay trades mainly with Argentina, Brazil, the United States, and western European countries.

**Transportation and communication.** Rivers serve as an important means of transportation in Paraguay. Asunción, the main port, lies on the Paraguay River about 1,600 kilometres from the Atlantic Ocean. To reach the ocean from Asunción, boats travel down the Paraguay to the Paraná River, which flows through Argentina and empties into the Atlantic. Paraguay's major cities are connected by paved highways, but less than a fifth of the country's roads are paved. Less than 2 per cent of all Paraguayans can afford a car. Friendship Bridge spans the Paraná River at the city of Cuidad del Este. It links the Paraguayan road system to a Brazilian highway that runs to the port of Paranaguá on the Atlantic coast. Paraguay's only major railway links Asunción and Encarnación. An airport near Asunción handles international flights.

Paraguay has four daily newspapers. About 5 per cent of the people own a radio, and less than 3 per cent own a television set. The nation's Constitution guarantees freedom of the press.

**Cattle ranching** is a major economic activity in eastern Paraguay. The low, grassy plains that cover much of the region are ideal for cattle grazing.

## History

**Early days.** Guaraní Indians were the first people to live in what is now Paraguay. They were fairly peaceable people who grew maize and other crops, hunted game, fished, and gathered wild fruits. In the early 1500's, Spanish and Portuguese explorers became the first whites to reach Paraguay. They were searching for a route across the continent to Peru and its treasures of silver and gold. In 1537, a Spaniard named Juan de Ayolas travelled up the Paraná and Paraguay rivers to a point north of what is now Asunción. He then went inland across the Chaco region. The men he left behind built a fort at Asunción. Under the leadership of Domingo Martínez de Irala, the settlement of Asunción became the seat of government for all of Spain's colonies in southeastern South America.

**The Jesuits.** Missionaries of the Jesuit order began to arrive in Paraguay in 1588 to convert the Guaraní to Roman Catholicism. They organized mission settlements called *reducciones* or *reductions,* where the Indians lived and worked. The Jesuits taught the Guaraní such skills as weaving, carpentry, and printing. Most of the Indians farmed the land or tended cattle. In return, they received food, clothing, and other goods. The reducciones became prosperous settlements that exported cotton, tobacco, yerba maté, hides, and wood. By the 1730's, the Jesuits had built about 30 reducciones with a total population of about 140,000.

Many Spanish colonists came to envy the wealth and power of the Jesuits. They wanted to use the cheap Indian labour themselves on their farms. The Jesuits, on the other hand, felt they were protecting the Indians from possible slavery and formed armies to guard the reducciones. Complaints from the colonists about the Jesuits' power led the Spanish king Charles III to expel the Jesuits from all Spanish territory in 1767. The Jesuits left Paraguay, and the reducciones were abandoned. Some Indians returned to their old ways of life. Others worked on estates of the Spanish colonists.

**Independence.** Throughout the 1600's and 1700's, many Paraguayans felt that Spain neglected their colony, and they resented the taxes the mother country demanded. In 1776, Spain made Paraguay part of one large colony called the Viceroyalty of La Plata. Buenos Aires, Argentina, became the capital of the viceroyalty. Paraguayans disliked having to take orders from Buenos Aires. In 1811, they overthrew the Spanish governor in Asunción and declared their independence. They formed an assembly to rule their new nation.

In 1814, the assembly chose José Gaspar Rodríguez de Francia, a Paraguayan lawyer, to head the government. Two years later, the assembly made him dictator for life. Francia governed by military force. He distrusted foreigners, and so he prohibited immigration and trade with other nations. Paraguay was isolated from the rest of the world, but it developed a strong sense of unity and independence.

Francia died in 1840. An assembly chose Carlos Antonio López to govern the country. In 1844, another assembly adopted a republican Constitution and named López president. Like Francia, López ruled as a dictator, but he reversed Francia's policies. López encouraged trade and invited foreign technicians to settle in Paraguay. He also built roads and schools and created a powerful army.

**A farmworker cuts sugar cane** on a Paraguayan plantation. Sugar cane and such crops as rice, cotton, and tobacco grow well in Paraguay's fertile soil and warm, humid climate.

**Military ruin.** López died in 1862. The Paraguayan legislature then elected his son Francisco Solano López president with dictatorial powers. López resented Paraguay's larger neighbours, Argentina and Brazil, and wanted to increase his country's influence in the region. In 1864, he went to war with Brazil. After Argentina refused to let Paraguayan troops cross its territory to attack Brazil, López declared war on Argentina. Argentina, Brazil, and Uruguay joined forces in 1865 and fought Paraguay in the War of the Triple Alliance, also called the Paraguayan War. The war lasted until 1870, when López was killed and Paraguay surrendered. The war left Paraguay in ruins. The population dropped from about 525,000 in 1865 to about 220,000 in 1871.

After the war, the country was plagued by struggles for power among rival political groups. More than 30 presidents headed the government of Paraguay from 1870 to 1932.

A dispute over ownership of the Chaco led Paraguay into war with Bolivia in 1932. Paraguay again suffered many casualties. The two nations signed a truce in 1935. A final settlement in 1938 gave Paraguay new territory in the Chaco.

**Political unrest** continued to trouble Paraguay after the Chaco War. A series of presidents again governed the country amid widespread complaints of low living standards, inadequate public services, and poor working conditions. Paraguay's economy improved during World War II (1939-1945). The United States provided loans and other aid to secure Paraguay's friendship. Paraguay declared war on Germany and Japan in 1945, but no Paraguayan troops fought in the war.

Civil war broke out in Paraguay in 1947 as rebels attempted to overthrow President Higinio Morínigo, who had ruled as dictator since 1940. The revolt was crushed. However, the Colorado Party, which had supported Morínigo, split into two groups. Morínigo was eventually forced to leave the country, and the rival Colorado groups fought for control of the government. Federico

Chaves, the leader of one group, seized power in 1950. General Alfredo Stroessner, commander in chief of the armed forces and head of the other group, forced Chaves to resign in 1954. Stroessner ran as the Colorado candidate in elections later that year and was elected president without opposition.

**Stroessner's rule and overthrow.** Stroessner used military and police powers to keep control of the government and was reelected seven times between 1958 and 1988. The government imprisoned many of its opponents and sent others into exile. By maintaining political stability, Stroessner was able to attract foreign aid and investments and began a broad programme of economic development. The government started projects to modernize agriculture, build roads, and promote new industries.

Stroessner's rule brought economic progress to a few Paraguayans. This led to political stability, but at the expense of a free and open democracy. A growing number of Paraguayans called for greater political and human rights. Early in 1989, Stroessner was overthrown during a coup led by General Andrés Rodríguez. Rodríguez, a member of the ruling Colorado Party, was elected president in May 1989.

A new constitution was adopted in June 1992, and Paraguay's first democratic, multiparty elections were held in May 1993. The Colorado Party's candidate, Juan Carlos Wasmosy, was elected president. The Colorado Party won the most seats in both houses of the National Congress, but not a majority.

**Related articles** in *World Book* include:

| | | |
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| Asunción | Paraguay River | Quebracho |
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| Mate | Petitgrain oil | |

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### Questions

Why did Spanish and Portuguese explorers go to Paraguay?
How has Guaraní culture influenced the arts in Paraguay?
What is the ancestry of almost all Paraguayans?
Why do few people live in the Chaco region of Paraguay?
Why do farms occupy only about a fifth of the land that could be used to grow crops in Paraguay?
What were *reducciones*?
What are Paraguay's two main languages? How is each language most commonly used in the country?
How did Alfredo Stroessner's rule affect Paraguay?
Why did Paraguay go to war with Bolivia in 1932? What did Paraguay gain as a result of the war?
How do Paraguayans celebrate religious holidays?

**Paraguay River** is a 2,549-kilometre river that flows southward through Paraguay, South America, cutting the country in two. It is a branch of the Paraná River and rises in south-central Brazil. From there, the Paraguay flows southward and joins the Paraná River at the Argentine boundary.

The Paraguay is a good river for navigation, except for channel shifts. Large steamboats go up the Paraná and continue on the Paraguay to Asunción, the capital of Paraguay. The channel of the Paraguay shifts position, so that settlements on the banks of the river are often left far from the main channel.

See also **Paraná River**.

**Paraguay tea.** See **Maté**.

**Paraguayan settlements.** In 1893, William Lane, an Australian social reformer of the labour movement, led a group of members of the New Australia Cooperative Settlement Association to establish a settlement in Paraguay, in South America. The settlement was based on socialist ideals. But the settlers met many difficulties and quarrelled among themselves. Lane disagreed with Gilbert Casey, who led a second group of settlers in 1894. Lane founded another settlement, which he called *Cosme*. The Australian poet Mary Gilmore edited the *Cosme Evening Notes*. The settlements continued to exist for some time, but lost their socialist character.

**Parakeet** is a small member of the parrot family. Parakeets are brightly coloured birds with green, red, blue, orange, yellow, or purple feathers. Their tails are either short and square, or long and pointed. The name also is spelled *parrakeet*, or *paroquet*.

Parakeets usually are affectionate and clever pets. They are natural acrobats, and can do many tricks on toy ladders and seesaws. The most common pet parakeet is the *budgerigar*, or *budgie*. This bird is native to Australia. It is also called the *budgerygah*, or *shell parakeet*. It lives well in captivity and becomes very tame. See **Budgerigar**.

You can tell the sex of an adult budgie by the colour of the skin at the nostrils. This patch of skin is called the *cere*. In the male the cere is bluish, while in the female it is brownish. Most budgies can be trained to talk. It is best to start when the bird is only a few weeks old. Say the same word or phrase over and over until the budgie repeats it. Both the male and the female can learn many words. Some trainers believe males learn faster.

Many people enjoy the hobby of parakeet breeding. Amateur parakeet breeders often find the hobby both fun and profitable. The best time of the year for breeding is in the spring. Birds hatched in the spring will benefit from the sun and warmth of the summer. Special housing for the birds is necessary, because the space for one bird is inadequate for two. The female bird lays an average of five eggs. The eggs hatch in about 18 to 20 days. A parakeet may live 10 years or more.

Seeds and fruit are the chief parakeet foods. Wild parakeets nest in trees and are swift fliers. Many species live in warm parts of the world. The *ground parakeet* of Australia and Tasmania nests in bushes. The *lovebird* is a small, colourful African parakeet. One of the largest parakeets is the *slatyheaded parakeet* of India, Thailand, and Laos. The tiny *hanging parrot* of Southeast Asia is a parakeet that sleeps hanging upside down from a tree branch.

The *Carolina parakeet* once was common in the United States, ranging northward to New York and Illinois. The head of this parakeet was orange and yellow, and its body green. These parakeets disappeared in the early 1900's. Many of them were killed because milliners wanted their feathers for hat trimming. The last flock was seen in the Florida Everglades in 1904.

**Scientific classification.** Parakeets are in the parrot family, Psittacidae. The ground parakeet is *Pezoporus wallicus,* lovebirds are *Agapornis,* hanging parrots are *Loriculus,* and the Carolina parakeet is *Conuropis carolinensis.*

See also **Bird** (picture: Birds as pets); **Lovebird.**

**Slatyheaded parakeet**
*Psittacula himalayana*
Found from Northwest India to Thailand and Laos
Body length:
About 38 centimetres

**Budgerigar**
*Melopsittacus undulatus*
Found in Australia
Body length:
About 18 centimetres

**The sex of an adult budgie** can usually be told by the colour of the *cere,* the patch of skin just above the beak. In males it is bluish, and in females it is brownish.

**Parallax** is the difference in direction of an object when seen from two positions that are not in a direct line with each other and the object. Hold up one finger. Look at it first with one eye and then with the other. Notice how the finger seems to change position in relation to more distant objects when seen with one eye and then with the other.

When you look with two eyes, each eye sees nearby things from a slightly different direction. Your mind solves a parallax problem when you look at nearby objects, and you tell how far away they are. A person blind in one eye has no parallax vision, and may have difficulty judging the distance of nearby objects.

Parallax is used in surveying to tell how far away a distant object is. A baseline of known length is laid off, the far-off object is viewed from each end of this baseline, and the two angles with the baseline are noted. Knowing the length of the baseline and the angles at each end, the height of the triangle can be calculated.

Parallax is used in astronomy for finding the distance to the stars. For a baseline, astronomers use the distance across the entire orbit of the earth around the sun, which is 299 million kilometres long. But the stars are so far away that this base line is big enough to get the parallax only of some of the nearer stars. See **Astronomy** (Measuring distances in space; diagram: Parallax).

**Parallel.** See **Map** (Geographic grids).

**Parallel bars.** See **Gymnastics.**

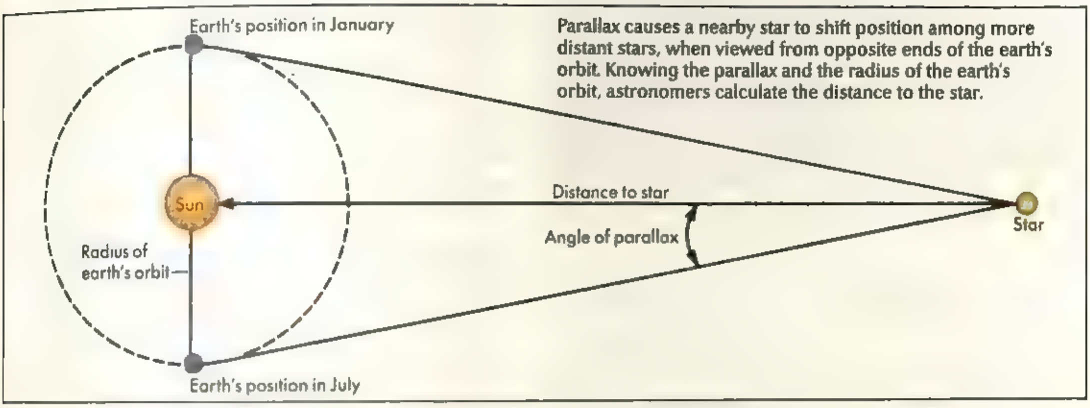
**Parallelogram.** See **Quadrilateral.**

**Paralysis** is the loss of the ability to move. It may be partial or complete, and temporary or permanent. The condition can affect muscles anywhere in the body. In many cases, paralysis is associated with loss of sensation in the affected part of the body.

In order to move, a muscle must be stimulated by nerves. Paralysis can follow an injury or disease that results in damage to (1) the central nervous system, (2) the peripheral nervous system, or (3) the muscles.

**Paralysis of central nervous system origin** can be extensive. The central nervous system consists of the brain and the spinal cord. An injury or disease that destroys brain cells may paralyse the arm, leg, and face muscles on one side of the body. Such brain damage generally produces *spastic paralysis,* in which the muscles are more tense than normal. Disease or injury of the spinal cord paralyses the muscles below the level of damage. For example, spinal cord damage in the neck region can cause *quadriplegia*—paralysis of the arms and legs. *Paraplegia*—paralysis of the legs—follows dam-

**Using parallax in astronomy**




age to the spinal cord below the neck region. Spinal cord damage also results in spastic paralysis. Damage to the *brain stem*—the portion of the brain that connects to the spinal cord—can result in the paralysis of muscles that control such automatic functions as breathing and swallowing.

Many conditions can produce paralysis of central nervous system origin. In newborn babies, such paralysis usually results from injury to the brain during birth. It can also result from spina bifida or other birth defects. Among children and young adults, road and sports accidents are leading causes of paralysis. Diseases that affect the central nervous system, such as meningitis and multiple sclerosis, also cause many cases of paralysis in young adults. Among older people, strokes and tumours are common central nervous system disorders resulting in paralysis.

Nerve cells in the central nervous system cannot regrow, and so their destruction generally results in permanent paralysis. However, some patients who have suffered brain damage can relearn certain movements by using undamaged parts of the brain.

**Paralysis of peripheral nervous system origin** generally affects an individual muscle or a group of muscles. The peripheral nervous system includes the nerves that connect the central nervous system to the muscles. Peripheral nerves can be damaged by various poisons, such as alcohol and lead; by diabetes and certain other diseases; and by cuts and other injuries. Inflammation of a peripheral nerve may also paralyse the muscle or muscles that the nerve controls. Damage to a peripheral nerve produces *flaccid paralysis,* in which the muscles remain limp.

Peripheral nerves can regrow, and so this type of paralysis may be temporary in some cases. Physiotherapy can help patients regain their strength if movement returns.

**Paralysis of muscular origin.** A group of hereditary disorders called *muscular dystrophy* ranks as the most common cause of paralysis due to muscle damage. For information on these disorders, see the article on **Muscular dystrophy.**

See also **Cerebral palsy; Palsy; Spastic paralysis.**

**Paramaribo** (pop. 180,000) is the capital, largest city, and chief port of Suriname, a country in northeastern South America. Nearly half of the people in Suriname live in Paramaribo. The city lies on the Suriname River, 20 kilometres inland from the Atlantic Ocean. For location, see **Suriname** (map). Industrial firms in Paramaribo manufacture aluminium, plywood, and various other products. The city is the home of the University of Suriname and the Suriname Museum.

Paramaribo grew up around a British fort built in the mid-1600's. After the abolition of slavery in 1863, many former slaves moved to Paramaribo. The city's population grew rapidly, and industrial development began in the early 1900's.

**Paramecium** is a tiny one-celled organism that can hardly be seen without the microscope. This type of organism is a *protozoan.* Paramecia live in ponds and slow-moving streams.

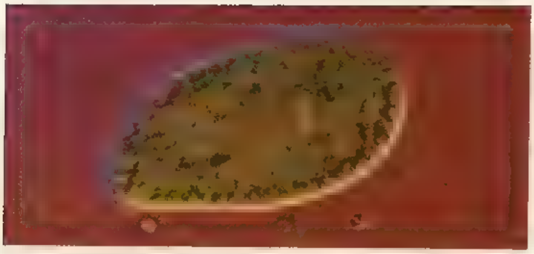
Like the amoeba, a paramecium is made up of watery material. The paramecium is clear on the surface and granular inside. On the inside, paramecia have one large nucleus and at least one smaller nucleus.

The paramecium has more special structures than the amoeba. A stiff layer on the outside gives it a permanent shape, unlike the amoeba. It looks like the bottom of a shoe. A paramecium is covered with fine hairs called *cilia.* It swims by beating its cilia. A network of fibres below the surface connects the cilia.

Food enters the paramecium through a hollow in one side called the *oral groove.* The oral groove leads to a tube called the *gullet.* Food in the gullet forms a ball which passes into the protoplasm as a food *vacuole.* The food is digested as the vacuole passes through the organism, and the waste is passed out from a special place called the *anal pore.*

Two star-shaped spots that seem to appear and disappear in the organism are the *contractile vacuoles.* They collect excess water and pass it to the outside.

Paramecia may reproduce by dividing in two across the middle. The nuclei divide, the rear half develops a new gullet, and the front half grows a new anal pore. Then the paramecium breaks into two individual organisms. Paramecia also show the beginnings of sexual reproduction. Two organisms may come together and exchange their nuclei. This process is called *conjugation.*



**The paramecium is a tiny one-celled animal.**

After conjugation occurs, the two paramecia separate and divide several times.

If the paramecium comes into contact with an unpleasant stimulus, it reverses the movement of its cilia, and backs away from the stimulus.

**Scientific classification.** Paramecia belong to the kingdom Protista.

See also **Protozoan.**

**Paramedic** is a trained medical worker who takes the place of a doctor in certain situations. Most paramedics handle routine medical duties, giving doctors more time with patients who need their expert care. In some countries, there are *emergency paramedics,* or *medical technician paramedics,* who give on-the-spot aid if a doctor is not immediately available. These men and women have saved the lives of many people.

The term *paramedic* was first introduced into general use in the United States. There it is still used mainly to describe an emergency medical worker with specialized skills. In other countries, regular ambulance crews may be called paramedics. Rural medical workers in such countries as India and China may also be called paramedics. Typical of these workers are the *barefoot doctors* who serve country villages throughout China. See **China** (Way of life [Health care]).

**A team of paramedics** provides emergency medical services, *above.* Such services include treatment for shock, bleeding, and heart attacks. Special equipment monitors the victim's bodily functions and sends a record of them to a nearby hospital.

**Duties.** The duties and training of paramedics may differ from country to country. Paramedics in most countries are primarily involved in emergency work. They give emergency care chiefly to accident victims and people struck down by heart attacks or sudden illness. Usually, two or more paramedics work together as a team. They may use a special ambulance that carries a variety of drugs and medical equipment. The equipment may include a *defibrillator* (a device to help correct irregular heartbeat).

Before treating a victim, a member of the paramedic team contacts a doctor at a nearby hospital by two-way radio. The team member reports the extent of any injuries, and passes on such information as the victim's blood pressure, breathing, and pulse. In some technologically advanced countries, paramedics may transmit to the doctor a patient's *electrocardiogram,* a recording of heart activity. All this information helps a doctor determine the right treatment for the patient.

**Training.** Men and women wishing to become paramedics undergo a selection procedure and an extensive medical training course. They learn basic life-support and first-aid techniques, including the treatment of shock and excessive bleeding, the restoration of breathing, and how to restart a heart that has stopped beating. In addition, they learn the correct operation of advanced medical equipment and the proper way to administer drugs and intravenous treatment.

See also **Fire brigade** (Emergency rescue operations); **Health; Medicine.**

**Parameswara** ( ? -1414?) was a Sumatran prince who founded the Melakan Sultanate in Malaya. This kingdom became one of the strongest political powers in Southeast Asia during the 1400's. *Parameswara* is a Sanskrit word meaning *Lord of All.*

According to Portuguese accounts, Parameswara was the son of a chief who served the Javanese king at Palembang, in Sumatra. When his father died, Parameswara declared himself independent of Java and escaped to what is now Singapore. There, he killed the local ruler and made himself chief. In about 1400, he fled to Malaya and settled in Melaka, making himself ruler.

According to Chinese records, Parameswara went to China in 1411 to pay his respects to the emperor. In 1414, Parameswara's death was announced by his son. The Chinese emperor then declared that the son should be the new ruler of Melaka.

Malay sources do not mention Parameswara. They state that the ruler who fled from Singapore and founded Melaka was Sultan Iskandar Shah.

**Paraná** (pop. 276,160) is a river port city in east-central Argentina. It is also the capital of Entre Ríos province. Paraná lies on the east bank of the Paraná River. A tunnel links it with the city of Santa Fé on the west bank. For the location of Paraná, see **Argentina** (political map).

Paraná is a shipping centre for grain, cattle, and sheep. It is also an administrative, cultural, and educational centre and the site of an air force base. Cement and glass are its only important manufactured products. Paraná was founded in 1588 and a Spanish mission community was established there in 1730. From 1853 to 1862, it was the capital of Argentina.

**Paraná River** is the second longest river in South America, with a length of about 4,000 kilometres. Only

the Amazon River is longer. The Paraná is formed in southern Brazil, where the Rio Grande and Paranaíba rivers meet. From there it flows south through Brazil and along the boundary between Brazil and Paraguay. Then it makes a boundary between Paraguay and Argentina, and travels through Argentina. It empties into the Atlantic Ocean through the estuary known as the Plata River (Río de la Plata). Ocean vessels can travel through the estuary and up the Paraná as far as Rosario, Argentina, 640 kilometres from the Atlantic. The Paraguay River is the main branch of the Paraná River. See also **Paraguay River; Río de la Plata.**

**Parani, Daing** ( ? -1724), was the most famous leader of the Bugis, a warlike people from Sulawesi, Indonesia. They conquered much of Malaya in the 1700's. The Bugis were seafarers who had begun to spread over the Indonesian Archipelago in the 1600's. They traded and fought round the coasts of Java, Sumatra, and the Malay Peninsula.

Daing Parani was the eldest of five sons. His father was a Bugis prince from Sulawesi. Daing Parani killed another prince in a fight and, as a result, the whole family was forced to flee. They wandered through Java, Johor, Melaka, and Siantan in the South China Sea.

In 1722, Daing Parani led his warriors into the Malay state of Johor. They drove out the ruler, Raja Kecil, and put Sulaiman, the son of a previous ruler, on the throne. But for many years the Bugis were really in control.

In 1723, Raja Kecil threatened the rulers of Kedah. Parani led a fleet of 60 boats to the rescue. A conflict followed and two years later Parani was mortally wounded as he sailed up the Kedah River.

**Paranoia.** See Mental illness (table: Mental illness terms; Schizophrenia).

**Paraplegia.** See Paralysis.

**Parapsychology** is the scientific study of certain alleged phenomena that do not exist according to current scientific assumptions. It primarily involves the study of extrasensory perception (ESP) and *psychokinesis* (the supposed ability to move objects by mental concentration). J. B. Rhine established the first parapsychology laboratory in the late 1920's at Duke University in Durham, North Carolina, U.S.A. Parapsychology is a very controversial field.

See also **Clairvoyance; Extrasensory perception; Mind reading; Psychical research; Telepathy.**

**Parasite** is an organism that feeds and lives on another living organism, called a *host.* Some authorities point out that all animals are parasites because they must rely on other living things for food. But in a stricter sense, parasites usually live on plants and animals bigger than they are. These organisms feed on only small amounts of the host's tissue or food at a time. They use the food to produce energy, and wastes are released directly into the host's body.

Parasites have varying effects on the body of their host. Experts believe that most parasites cause little or no harm to their host. For example, one type of amoeba lives in human intestines. It feeds on partly digested food and other intestinal parasites without causing any obvious ill effects. Other types of parasites may cause great harm. For example, the *protozoans* (one-celled organisms) that cause malaria are parasites in the red blood cells of human beings.

**Parasites that feed on people and animals** cause many types of disease. For example, one type of amoeba destroys the lining of the intestines of human beings. This produces the painful disease called amoebic dysentery. Other protozoans may invade the blood of mammals and cause diseases such as malaria. Blood-sucking insects and ticks pick up parasites from infected animals and pass them on to other animals and human beings.

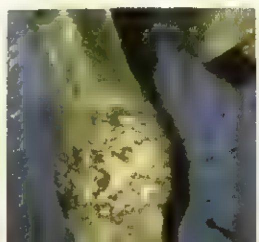
Parasitic flatworms and roundworms cause serious damage and often kill their hosts. One group of flatworms, called flukes, live in the intestines, liver, lungs, or blood of animals. Another group, the tapeworms, mature in the intestines of animals. They attach themselves to the intestinal wall with suckers or hooks. The tapeworms then absorb digested food, depriving the host of nourishment. Hookworms are the most harmful group of roundworms. They live in intestines and feed on the blood of their host.

Other parasites attack the skin. For example, parasitic fungi cause ringworm, a skin disease in human beings. Some insects, ticks and mites feed by biting the skin of people and animals. Their bites are irritating, but the diseases these parasites spread are far more serious. Certain ticks transmit relapsing fever to people. One type of mosquito spreads yellow fever and another carries malaria. The tsetse fly transmits African sleeping sickness. People may get typhus from a body louse.

Insects, ticks, and mites may be parasitic only during particular periods of life. For example, only adult fleas are parasites. Red bugs and screwworms, a type of fly, are parasites only in their *larval* (infant) stage. Some animal parasites live on plants and may kill them. *Aphids* (plant lice) and threadworms are examples.

**Parasites that feed on plants** include various types of insects, roundworms, and fungi. Aphids, scale insects, and threadworms may kill their plant hosts. Parasitic fungi cause wheat and bean rust, potato and tomato blight, apple scab, and downy mildew of grapes. Mistletoe, a parasite of forest trees, is called a *partial parasite* because it makes some of its own food. Fungi cause lumpy jaw, a disease that injures the jaws of cattle and pigs that have eaten the affected plants. Experts estimate

**Apple scab** is caused by a fungal parasite. It appears as brown patches on apple blossoms, fruit, and leaves.



**Downy mildew** is a fungus that attacks fruit and vegetable plants. It grows from a single cell called a *spore.*

**A tapeworm** lives in intestines of people and animals.

**The Rocky Mountain wood tick** infects humans.

**The mite** lives on various plants and animals.

**Mistletoe** is a plant parasite that grows on trees.

**Trypanosomes** live in the blood of vertebrates. Tsetse flies carry the parasite, which causes sleeping sickness.

**The trichina worm** lodges in the muscles of pigs and humans. It causes the painful disease called *trichinosis.*

**Plasmodium vivax** is one of the tiny parasites that cause malaria, a serious disease of human beings.

**Black stem rust** is a fungus that lives part of its life on barberry plants, *above,* and part on wheat plants.

that plant parasites destroy about 3 billion U.S. dollars worth of crops in the United States each year.

Most *bacteria* (one-celled organisms) are parasites. Bacterial diseases, such as tuberculosis and pneumonia, are usually considered apart from those caused by other parasites.

**Related articles** in *World Book* include:

| | | |
|---|---|---|
| Actinomycosis | Fungi | Roundworm |
| Amoeba | Hookworm | Rust |
| Aphid | Horsehair worm | Saprophyte |
| Bacteria | Ichneumon wasp | Schistosomiasis |
| Chigger | Louse | Sleeping sickness |
| Dodder | Malaria | Smut |
| Dysentery | Mildew | Symbiosis |
| Elephantiasis | Mistletoe | Tapeworm |
| Ergot | Mite | Tick |
| Flea | Mosquito | Trichina |
| Fluke | Pinworm | Yeast |
| Fungal disease | Rot | |

**Parathion.** See **Insecticide** (Organic insecticides).

**Parathyroid gland** consists of four tiny glands that function as one gland. These glands lie in the front of the neck close to the thyroid gland. The parathyroid glands secrete parathyroid hormone (PTH), also called *parathormone,* into the blood. PTH helps regulate the amount of calcium and phosphate in the body. These minerals are necessary for a number of important body processes, including bone growth and muscle and nerve function.

When the level of calcium in the blood becomes low, the parathyroid glands increase secretion of PTH. PTH causes the kidneys to produce urine that contains less calcium and more phosphate than normal. The urine is then expelled from the body. PTH also frees calcium and phosphate from bone. In addition, PTH increases the amount of calcium absorbed from the digestive tract.

Malfunctioning of the parathyroid glands can lead to extremely low levels of calcium in the blood. Severe calcium deficiency results in *tetany,* a dangerous condition that is characterized by chronic muscle spasms.

**Paratroops.** See **Airborne troops.**

**Paratyphoid fever.** See **Typhoid fever.**

**Parchment** is an animal skin that has been prepared as a surface for writing. The word *parchment* usually means a writing material made from the skins of sheep, goats, or calves. Such materials are very durable. Parchment scrolls have survived from about 1500 B.C.

In making parchment, the skins are first washed and then placed in lime to remove the hair and fat. Next, the skins are stretched on a frame and thinned with knives and scrapers. Finally, the skins are rubbed with chalk and pumice in order to create a smooth, white writing surface.

**Vellum** is a form of fine parchment made from the skins of lambs, kids, or calves. This high-quality parchment has been used for important writings such as charters, university diplomas, and wills.

**Heavy parchment** is made from the skins of donkeys, calves, wolves, and goats. It is used for drumheads.

**Parchment paper,** or *vegetable parchment,* is made by dipping pure, unsized paper into a cooled mixture of sulphuric acid and water, and then washing and drying it under pressure. This makes the paper partly transparent and much stronger than ordinary paper. It is used

mainly for legal documents and the printing of maps.

**History.** Parchment was especially popular in the ancient cities of Asia Minor. The Jews, Persians, and other ancient peoples used it for sacred and literary writings. Beginning about 200 B.C., parchment gradually replaced papyrus as the most commonly used writing material. Parchment remained the leading writing material in the West until the introduction of paper from the Middle East in the A.D. 1200's. Paper largely replaced parchment about the time printing was being developed in Europe during the 1400's. Parchment is still sometimes used for important documents.

See also **Bible** (picture: Illuminations); **Book** (Early books); **Library** (Libraries of animal skins); **Manuscript**; **Papyrus**; **Scroll**.

**Pardon,** in law, has two meanings. It is either a complete release from a guilty conviction for a crime, or a *commutation* (substitution or exchange) of the sentence awarded after a criminal conviction. Pardons are granted by chief executives, such as kings, presidents, and governors. The executive sometimes acts on a recommendation made by a board, a commission, or a single individual.

The first type of pardon differs from parole. A person on parole must report from time to time to an individual named by the board. But a person who receives this type of pardon is entirely free. The person is not regarded as a criminal, because the pardon has the effect of wiping out the conviction. The pardon may be used to free a person whose innocence is established after conviction.

The second type of pardon is sometimes used in countries or states where death is the usual punishment for murder. A sentence of life imprisonment might be substituted for death. In this case the pardon might be said to be *conditional.*

See also **Amnesty**; **Parole**.

**Paré, Ambroise** (1510?-1590), was a Frenchman who became one of the greatest surgeons in the history of medicine. His formal education was sketchy, but he learned on the battlefield as a surgeon in the French Army. Paré stopped treating gunshot and surgical wounds with boiling oil, which was the practice, and learned to rely on the power of nature to heal. He also revived the practice of tying off blood vessels in amputations. In 1552, Paré became surgeon to Henry II, and continued as court surgeon to the three succeeding French kings.

Paré was born the son of a barber at Bourg-Hersent, near Laval, France. In his day, doctors considered surgery beneath their dignity, and most operations were performed by barber-surgeons. Paré's work helped to raise the standing of surgery.

See also **Medicine** (picture: Surgical advances).

**Parent** is a father or mother. There are two types of parents, *biological parents* and *social parents.* A child's biological parents are the man and woman who physically produce the baby. They contribute the mental and physical characteristics that the child inherits. The child's social parents—who may not be the same as its biological parents—are the ones who raise the child. This article discusses social parents.

**The role of parents** is to provide care, love, and training for their children. Children must have years of physical care, including food, shelter, and protection from harm. Love and affection are also necessary to stimulate children to learn and mature. This love should come from a person or persons with whom the children can develop a lasting attachment. Youngsters who have been raised in institutions and have not received enough individual attention or love often experience problems in forming personal relationships later in life. They may also fail to achieve other kinds of normal growth and development, even though they have received the necessary physical care.

Parents play a major role in a process called *socialization,* by which children learn to become independent members of society. For example, parents train their youngsters to speak, to dress themselves, and to perform other basic activities. Girls and boys also learn *sex roles*—that is, the roles they are expected to play as adult females or males—by identifying with the parent of the same sex.

Children are born with great individual differences in intelligence, physical ability, and temperament, and so they vary greatly in talent, personality, and other characteristics. Although parents greatly influence a child's development, they are not completely responsible for his or her strengths and weaknesses. Other important influences, over which parents have little control, also affect a child's attitudes and development. These influences may include friends, teachers, and even characters on television.

**Changes in parenthood** have resulted from the many scientific, economic, and social changes during the last hundred years. During the 1800's, most children, other than those of the privileged classes, became independent and self-supporting as teenagers. Today, childhood is more prolonged, and parents spend more years and more money raising their children.

A couple's potential childbearing years still total about 20 years. But modern parents have fewer children during that time because of new birth control methods, in particular the oral birth control pill (see **Birth control**). People now have greater freedom than ever before in deciding whether to become parents. Couples can choose how many children they wish to have and when to have them.

Another change is that greater numbers of women have entered the work force. Many of them get jobs because of financial necessity or to achieve freedom from women's traditional roles of child rearing and housework. The traditional division of tasks between parents has changed. Many fathers now play a more active role in the care of children and the home.

Children today are dependent upon their parents' care for a longer time, but many mothers are seeking to expand their role beyond that of a parent. As a result, there is a shortage of child care. Nurseries or crèches provide one solution to this problem.

In the past, young parents got help and instruction in child rearing from their own parents or other relatives. Today, far fewer families have an extra adult who shares parental responsibility. This lack of help, plus the increased duration of obligations to children, has created a need for information about raising children. The need accounts for the popularity of child care books and *parent education* groups or courses.

**Related articles** in *World Book* include:

| | |
|---|---|
| Adoption | Foster parent |
| Baby | Guardian |
| Child (The role of parents) | Reproduction |
| Family | Socialization |

**Parenthesis** is a word, phrase, or sentence added to another sentence for the purpose of extra explanation, information, or comment. The word *parenthesis* comes from the Greek word *parentithenai,* which means to *put in* or to *place in.* In writing, a parenthesis is often set off in *parenthetical marks* ( ), called *parentheses,* or *brackets.* Parenthetical phrases may also be set off between dashes or commas. See also **Algebra** (Symbols in algebra); **Punctuation.**

**Pareto, Vilfredo** (1848-1923), was an Italian sociologist and economist known chiefly for his theories on political behaviour. Pareto believed that people base their political decisions and all other actions on emotion, instinct, and similar drives—rather than reason. He also maintained that all societies are governed by a small group of rulers called an *elite.* According to Pareto, the ruling elite is continually overthrown and replaced by people from the lower ranks, who in their turn become the new elite. He called this process the *circulation of elites.*

In economics, Pareto theorized that the amount of consumer satisfaction with a product cannot be measured. However, consumers can rank products in order of preference, unless they are indifferent about which of two or more products they buy. This idea led to the development of *indifference analysis,* a method of studying consumer behaviour based on the ranking of preferences. Pareto also developed new ways to apply mathematics to economic problems.

Pareto was born in Paris. He trained and worked as a civil engineer before taking up sociology and economics. Pareto's books include *A Manual of Political Economy* (1906) and *The Mind and Society* (1916).

**Paricutín** is the most recent volcano to form in the Western Hemisphere. It stands near the city of Uruapan in southwestern Mexico (see **Mexico** [physical map]). It was named after the village of Paricutín, which was destroyed by the volcano.

The volcano appeared in a field of maize on Feb. 20, 1943, from a crack in the earth. Volcanic material began to erupt from the crack and formed a cone around the opening in the earth. Volcanic explosions sent clouds of gas and ash 6 kilometres into the air. By the end of one week, the cone stood about 140 metres high. After two months, it had reached about 300 metres.

Paricutín's lava destroyed the villages of Paricutín and San Juan Parangaricútiru and damaged nine other villages. The volcano also turned a large area of farmland and forests into wasteland before it appeared to cease activity in 1952.

Today, Paricutín stands 410 metres above its base and 2,808 metres above sea level. Lava from Paricutín covers about 24 square kilometres, and volcanic ash and sand extend over 50 square kilometres. Paricutín, like many other volcanoes in southern Mexico, is part of the *Volcanic Axis,* also called the *Transversal.* The Volcanic Axis is a line of volcanoes that extends across Mexico in an east-west direction.

See also **Volcano** (picture).

**Paris,** in Greek mythology, was a son of Priam, king of Troy. Paris' mother, Hecuba, dreamed that her unborn son was a torch that set the country on fire. A soothsayer said the dream meant the child would cause the destruction of Troy. Priam gave Paris to a slave and ordered him to kill the child. The slave left him to die, but a shepherd saved him and raised him as his own son. Paris married the nymph Oenone.

One day messengers came from Priam to take a bull as a prize for a wrestling contest. They took Paris' favourite bull, so he entered the contest and won it back. His sister Cassandra recognized him, and Priam accepted him, disregarding Hecuba's dream.

Zeus, the king of the gods, had Paris judge a contest among three goddesses—Aphrodite, Athena, and Hera—over the Apple of Discord. This apple bore the words "To the fairest." Aphrodite promised Paris the most beautiful woman in the world, and so he chose her over the other goddesses. Hera and Athena hated him and Troy after that.

Paris fell in love with Helen, the beautiful wife of Menelaus, and took her to Troy. Menelaus was the king of Sparta, in Greece. Agamemnon, Menelaus' brother, led the Greeks in the Trojan War to get Helen back. Late in the war, Paris killed the Greek hero Achilles with a bow and arrow, but was himself later killed by the Greek archer Philoctetes.

See also **Helen of Troy; Trojan War;** Troy (The legendary Troy).

**Paricutín** is the most recently formed volcano in the Western Hemisphere. It appeared in 1943 when lava began to erupt from a crack in a Mexican maizefield. It apparently ceased activity in 1952, after having formed a cone 410 metres high.

© Gerard Halary, Shostal

**The heart of Paris** includes many beautiful buildings that are hundreds of years old. The Seine River flows around the Île de la Cité (Island of the City), *right.* The magnificent Cathedral of Notre Dame towers above the other buildings on the island.

# Paris

**Paris** is the capital and largest city of France. It is one of the most beautiful cities in the world. Lovely gardens and parks and historic squares are located throughout Paris, the Seine River winds its way through the centre of the city, and chestnut trees line the city's famous avenues. At night, floodlights shine on Paris's many magnificent palaces and monuments. The gleaming beauty of Paris and its importance as a centre for education and intellectual pursuits have given it the nickname *la Ville Lumière* (City of Light). This name originated during the Age of Reason (1600's to late 1700's).

Every year, more than two million tourists visit Paris. The most popular tourist attraction is the Eiffel Tower. This huge structure is known throughout the world as the symbol of Paris. Tourists also flock to the Louvre, one of the world's largest art museums, and visit the soaring Cathedral of Notre Dame. The city is also famous for its many restaurants, pavement cafes, theatres, and nightclubs.

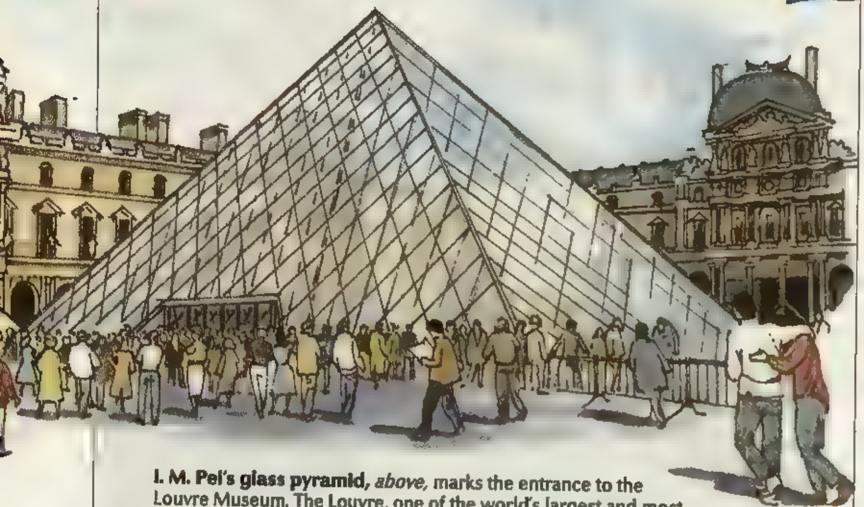
Paris has long been a world centre of the arts and education. For hundreds of years, important styles in painting and literature have developed there. About two-thirds of France's artists and writers live in Paris. The University of Paris, one of the largest universities in the world, is more than 800 years old.

The Paris area is also a great industrial centre. About a quarter of France's labour force lives in the crowded area. Factories in and near Paris turn out a wide variety of products, including most of France's cars. Paris is known for such luxury products as expensive jewellery, perfume, and women's high-fashion clothing. Famous designers of women's clothing create Paris fashions that are copied in many other countries.

### Facts in brief about Paris

**Population:** city, 2,175,200; metropolitan area, 9,060,257.
**Area:** 105 km²; metropolitan area, 479 km².
**Altitude:** 76 m above sea level.
**Climate:** *Average temperature*—January, −2 °C; July, 20 °C. *Average annual precipitation* (rainfall, melted snow, and other forms of moisture)—56 cm. For the monthly weather in Paris, see France (Climate).
**Government:** *Chief executive*—mayor (six-year term). *Legislature*—city council of 109 members (six-year terms).
**Founded:** 52 B.C.

# Paris *City of Light: A jewel that glitters with beauty and charm.*



**I. M. Pei's glass pyramid,** *above,* marks the entrance to the Louvre Museum. The Louvre, one of the world's largest and most famous museums, contains over a million works of art.

Capital of France and largest city (pop. 2,176,243). Divided into *Right Bank* (north of Seine) and *Left Bank* (south of Seine). Offices, fashionable shops on Right Bank. Left Bank famous as centre of artist and student life.

World capital of art and learning. Many notable attractions. Beautiful Champs Élysées (Elysian Fields) is city's best known avenue. Excellent restaurants; fine wine and good cooking are important part of Paris life.

Major industrial centre. World centre of jewellery, perfume, women's high-fashion clothing.

**The Palace of Versailles,** *above,* now a national museum, was built during the early 1600's. It was enlarged by King Louis XIV in the mid-1600's. Its beautiful grounds include formal gardens and a park dotted with statues and ponds.

**The Basilique du Sacré Coeur,** *right,* rises atop Montmartre, the tallest hill in Paris. The gleaming white church is one of the most famous sights of Paris. Construction on the church began in 1875.

**52 B.C.**
**Roman invaders** established colony called *Lutetia* on what is now Île de la Cité.

**507**
**Paris became capital** of Frankish kingdom under Clovis.

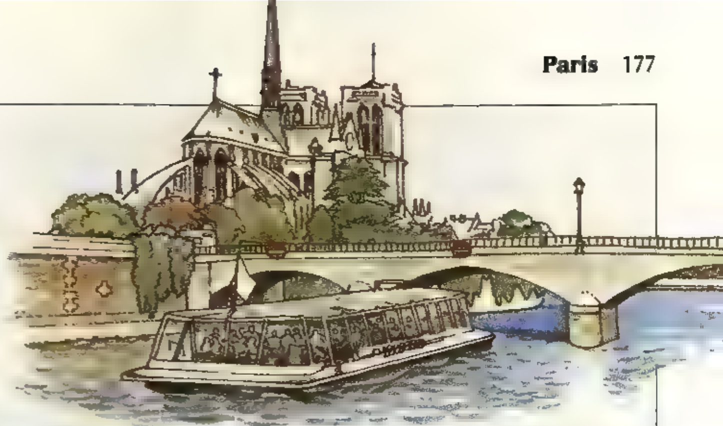
**1100's**
**University of Paris** founded in *Latin Quarter* of Left Bank.

**1180-1223**
**King Philip II** developed Paris as centre of culture and learning.

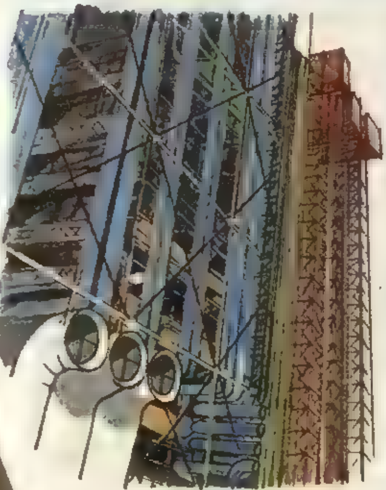
**1400's-1500's**
**During Renaissance,** French kings developed culture and beauty of Paris.

**1789-1799**
**French Revolution** ended absolute rule by French kings.

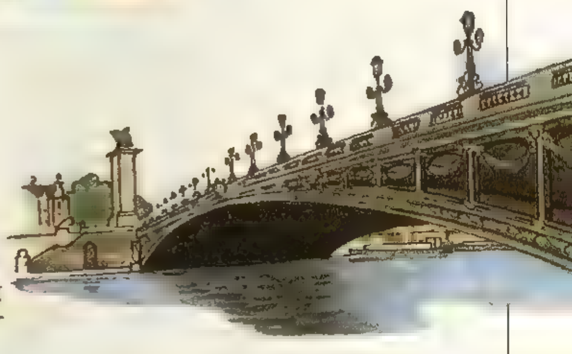
**The Eiffel Tower** is known throughout the world as a symbol of Paris. It stands on the Left Bank in a park called the Champs de Mars. Alexandre Gustave Eiffel designed the tower for the World Exhibition of 1889. The wrought-iron structure rises 300 metres from a base 101 metres square. At night, lights on the tower turn it into a glittering spectacle.



**The Cathedral of Notre Dame,** *above,* is the most famous church in Paris. It stands on the Île de la Cité in the centre of the city. Construction of the cathedral took place between 1163 and 1250. It is a majestic example of Gothic architecture.



**The Beaubourg,** *left,* or Georges Pompidou Arts Centre, is a controversial and popular attraction. Lifts, brightly-painted pipes, and other structural elements are visible from outside the building. The centre houses a huge collection of modern art and hosts many exhibits.



**Pont Alexandre III,** *above,* is an elegant steel bridge adorned with garlands and other ornate decorations. Mythical figures stand atop four tall towers at the entrances to the bridge. The cornerstone for the bridge was laid in 1896.

Paris was centre of revolutionary activity.

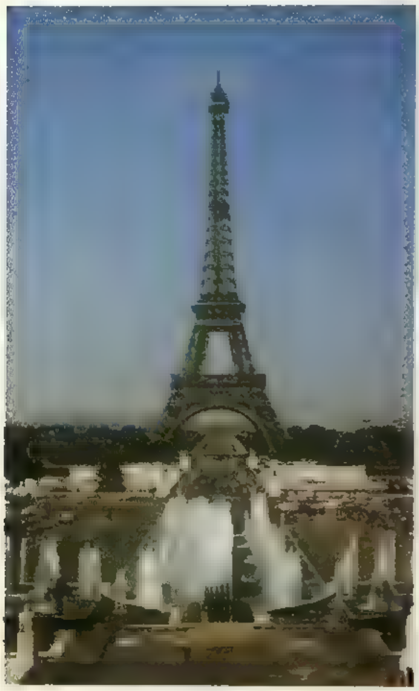
**1919-1938**
**Many great writers,** including Ernest Hemingway, gathered in Paris between world wars.

**1940-1944**
**German troops** occupied Paris during World War II.

**1968**
**Students and workers** staged protests that led to resignation of President de Gaulle.

**1977**
**Pompidou Arts Centre** opened. Named after Georges Pompidou (1911-1974), former president of France.

**1978**
**La Défense opened:** Huge complex with offices, shops, entertainment and sports facilities.



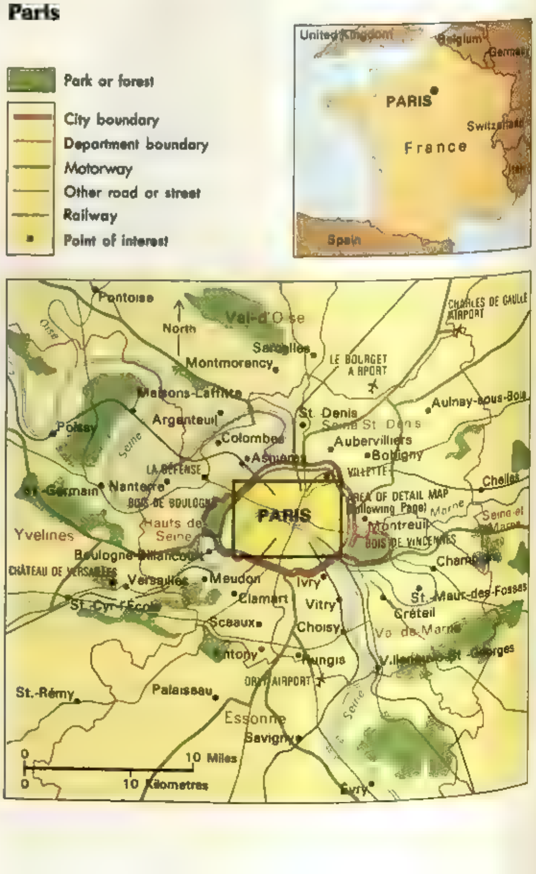
**The sights of Paris** include the famous Eiffel Tower and pavement cafes. The Eiffel Tower rises 300 metres in the Champs de Mars, a popular park. People enjoy stopping at pavement cafes to eat and drink, as well as to observe life around them.

The history of Paris goes back more than 2,000 years. In 52 B.C., soldiers of ancient Rome found in the area a tribe of people who lived by fishing. The Romans established a colony there. During the Middle Ages, Paris grew rapidly and became a major centre of culture and government. In Paris, in 1792—during the French Revolution—France became one of the first nations to overthrow its king and set up a republic. In World War I (1914-1918), Paris taxi drivers helped win the First Battle of the Marne by speeding French troops to the front line in their taxis. German forces occupied Paris during World War II (1939-1945).

Two thousand years ago, the Roman general Julius Caesar described the people of what is now Paris as "clever, inventive, and given to quarrelling among themselves." This description is still considered true of Parisians today. They are known for their creative arts and crafts, and their strong political feelings lead to bitter quarrels. The similarities among the people of Paris over thousands of years help prove a French saying: "The more things change, the more they stay the same."

Today, dramatic changes are taking place in Paris. Modern office and housing complexes are being constructed in the city, along with new cultural and recreational structures. At the same time, its beautiful old buildings and monuments are being restored. Paris is staying young while preserving the treasures of its past.

**Paris**




## City

Paris lies about 170 kilometres southeast of the English Channel in the heart of a fertile, heavily populated lowland called the Paris Basin. For the total population

of Paris, see the *Facts in brief* table with this article. One of the world's most crowded cities, Paris has an average of more than 20,700 people per square kilometre.

The Seine River curves through Paris for about 13 kilometres from east to west. The section of Paris north of the river is called the Right Bank. Busy offices, small factories, and fashionable shops are on the Right Bank. The Left Bank, south of the Seine, is a famous centre of artist and student life.

Paris is laid out according to plans that developed over hundreds of years. An island in the Seine, the Île de la Cité (Island of the City), is the heart of Paris. The city was founded on this island more than 2,000 years ago. Paris soon spread out on both banks of the river. In about 1200, a fortified wall was built around the city. Paris continued to grow, and new walls were built in a series of widening circles. Today, there are boulevards where the walls once stood.

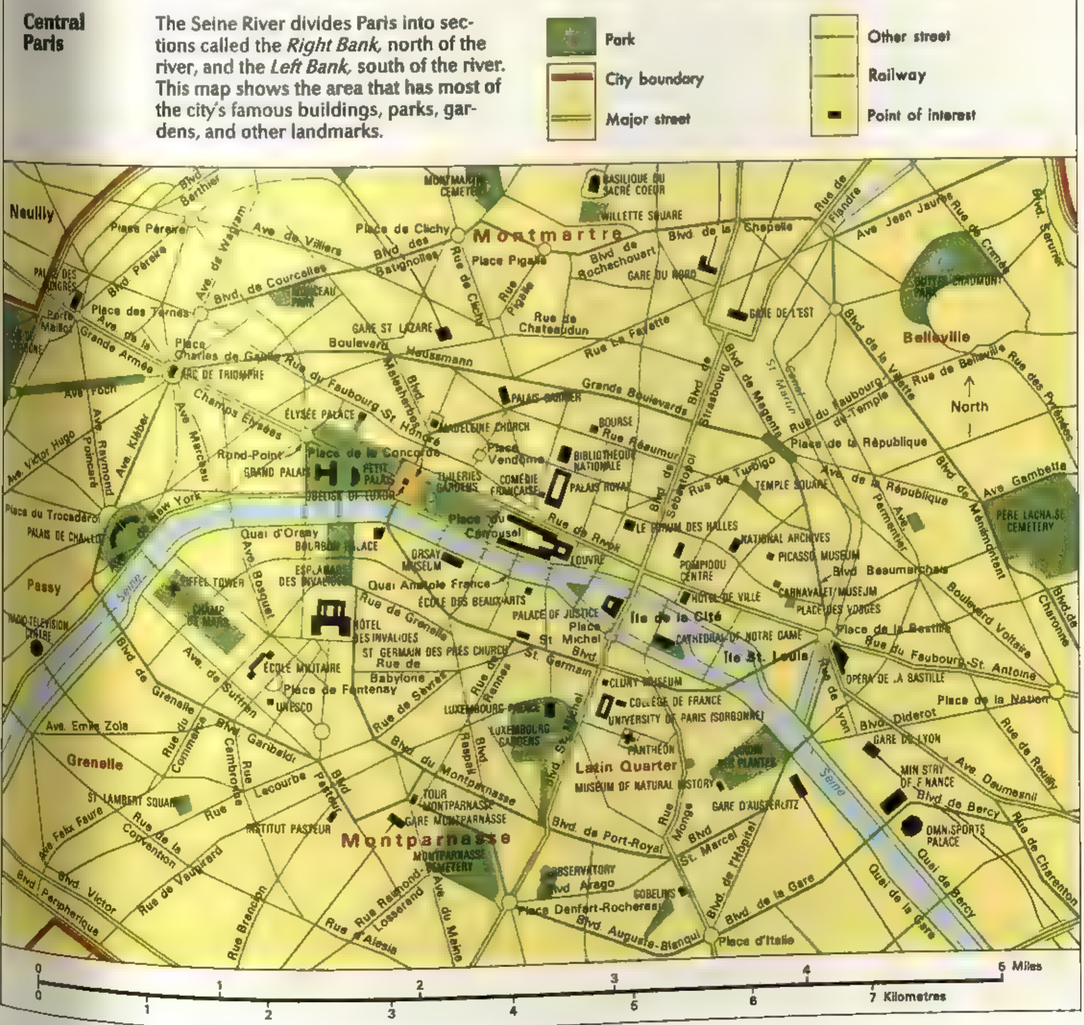
**Gardens, squares, and parks.** Paris has been described as being like a woman with flowers in her hair. This description comes from the many beautiful gardens and parks throughout the city. The Tuileries Gardens, on the Right Bank, are one of the finest formal French gardens. Neat flower beds and beautiful statues line a long path through the Tuileries. Children sail toy boats in two round fountains along the broad path. See **Tuileries.** They also sail boats in the central pool of the Luxembourg Gardens, on the Left Bank.

The Champs Élysées (Elysian Fields) is Paris' most famous avenue. It is lined with beautiful gardens and rows of chestnut trees. Along its route is the Rond-Point. This landscaped roundabout has magnificent fountains, and formal flower beds trimmed to look like a huge bouquet. At the western end of the Champs Élysées stands the Arc de Triomphe (Arch of Triumph). Emperor Napoleon I started to build this huge stone arch as a monument to his troops in 1806. It was completed in 1836. The arch rises in the Place Charles de Gaulle (formerly the Place de l'Étoile), one of more than 130 public squares in Paris. Broad avenues extend from the square in 12 directions. See **Arc de Triomphe.**

At the eastern end of the Champs Élysées is the Place de la Concorde (Square of Peace). This square was built during the 1700's. Within it are eight huge statues, two

**Central Paris**

The Seine River divides Paris into sections called the *Right Bank,* north of the river, and the *Left Bank,* south of the river. This map shows the area that has most of the city's famous buildings, parks, gardens, and other landmarks.



**The Arc de Triomphe** is an impressive monument at the western end of the Champs Élysées. Napoleon I ordered its construction to honour his military victories.

**The Place de la Concorde** stands at the eastern end of the Champs Élysées. It features fountains, statues, and an Egyptian pillar called the Obelisk of Luxor.

fountains, and the Obelisk of Luxor, a stone pillar from Egypt (see **Obelisk**). The obelisk stands 23 metres high. During the French Revolution (1789-1799), a *guillotine* (beheading machine) stood in the square. Hundreds of people, including King Louis XVI and his wife Marie Antoinette, were executed on it. Other important squares in Paris include Carrousel, Nation, République, Saint Michel, Vendôme, and Vosges.

The Champ de Mars (Field of Mars) is a beautiful park that was once a military training ground. Among its gardens and tree-lined lawns are many attractions for children, including miniature car-racing tracks, merry-go-rounds, puppet shows, and donkey rides. In the Champs de Mars stands the Eiffel Tower, built for the 1889 World's Fair. This world-famous symbol of Paris rises 300 metres. Visitors can dine in restaurants on various platforms in the tower and enjoy spectacular views of Paris. See **Eiffel Tower.**

Paris' largest parks are the Bois de Boulogne (Forest of Boulogne) and the Bois de Vincennes (Forest of Vincennes). These parks have several lakes for boating, horse-racing tracks, restaurants, theatres, and zoos.

**Famous buildings.** The Louvre Palace, one of the largest palaces in the world, extends for 0.8 kilometre along the Seine. The palace houses the Louvre Museum, one of the world's largest art museums. The Louvre dates from about 1200, when it was built as a royal fort. It was rebuilt during the 1500's as the royal palace. From then on, many French rulers expanded the Louvre. Napoleon III began to build the last addition in 1852. From 1984 to 1989, the Louvre's exhibition space was restored and enlarged, and a modern glass pyramid entrance was built in the courtyard. The modern entrance contrasts sharply with the traditional architecture of the Louvre building itself. See **Louvre.**

Many other historic buildings of Paris also house government offices. The main house of Parliament, the National Assembly, meets in the Bourbon Palace, com-

**Luxembourg Gardens** provide Parisians and visitors with a quiet, scenic resting place in the busy Left Bank area. The landscaped grounds include rows of colourful flowers. Luxembourg Palace, *background,* overlooks Luxembourg Gardens. It dates from the early 1600's.

pleted in 1728. The Luxembourg Palace is the meeting place of the Senate, the less powerful house of France's Parliament. The palace was built during the early 1600's. The president of France lives in the Élysée Palace, built in 1718. The Palace of Justice stands where the ancient Roman governors and early French kings lived on the Île de la Cité. Today, French high courts meet there. The Hôtel de Ville (Town Hall) stands where Paris' first town hall was built in 1357.

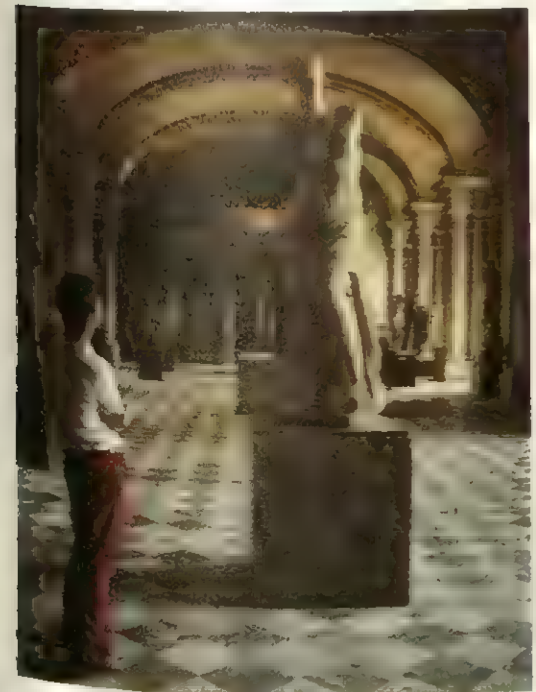
The domed Panthéon is a monument to French heroes and other famous people. It was originally a church named after Sainte Geneviève, the patron saint of Paris. In A.D. 451, she organized the city's defences against a threatened attack by Attila the Hun. Some people believe that her prayers prevented the attack and saved the city. In 1791, the church was named the Panthéon, and became a burial place. Jean Moulin, a hero of World War II, was buried there in 1965. After German troops occupied France in 1940, Moulin organized forces to fight them. The Germans captured Moulin and tortured him to make him name his friends. Moulin tried to kill himself so he would not weaken and betray them. He later died from the torture in 1943.

The Cathedral of Notre Dame, the most famous of Paris' many beautiful churches, stands on the Île de la Cité. The cathedral was completed in the mid-1200's, and is known for its majesty and its stone carvings (see **Notre Dame, Cathedral of**). Many Roman Catholic pilgrims visit the Basilique du Sacré Coeur (Basilica of the Sacred Heart). This basilica, with its huge bell tower and onion-shaped dome, is one of the city's most familiar sights. The gleaming white church stands on the top of Montmartre, the tallest hill in Paris at 129 metres high.

**Arts.** Paris has long been famous as a world centre of the arts. Thousands of actors, musicians, painters, and writers work or study there. Many of them live in the Montmartre district. They come from all parts of France and from many other countries. They are attracted by Paris' special atmosphere of freedom in the arts, in which new styles can develop. Painters and sculptors show their work at exhibitions called *salons,* and in the city's many art galleries. Outstanding painters and sculptors who lived in Paris include Georges Braque, Pablo Picasso, Pierre Auguste Renoir, and Auguste Rodin. Famous novelists and playwrights who lived in Paris include Albert Camus, André Gide, Victor Hugo, Marcel Proust, and Jean-Paul Sartre.

Paris has about 60 theatres. The Comédie-Française, Paris' most famous theatre, offers classics of French drama. The Opéra de la Bastille presents opera. The Palais Garnier, which formerly housed the opera and was generally called the Opéra, holds dance programmes. Paris also has several symphony orchestras.

**Museums and art galleries** of Paris are storehouses of many priceless art treasures. The works of painters and sculptors of the late 1800's and the 1900's are displayed in the National Museum of Modern Art in the Georges Pompidou National Centre of Art and Culture. The Pompidou Centre also houses a public library and music and industrial design centres. The building's transparent design has caused a great deal of controversy. All the structural and service elements, such as beams and lifts, are multicoloured and visible from the outside. The famous Louvre Museum displays works considered to be of lasting greatness. It houses such masterpieces as Leonardo da Vinci's *Mona Lisa* and the



**The Venus de Milo** is one of the many art treasures in the Louvre, one of the world's largest art museums. The Louvre has about 13 kilometres of galleries.

**The Opéra de la Bastille,** which opened in 1990, is one of the largest and most technically advanced opera houses in the world. It is located in the historic Place de la Bastille.

**A Parisian artist** paints, and displays his works for sale, in the Montmartre district. Many artists live in Montmartre. The area is also noted for its nightclubs.

**The Pompidou Centre** is famous for its extremely modern design. The building's structural elements are visible from the outside. It houses artworks and also includes a library and music and industrial design centres.

Greek statue *Venus de Milo*. The huge Louvre building also houses the Museum of Decorative Art. This smaller museum has a fine collection of antique French furniture. The Picasso Museum, originally a mansion built in the 1600's, exhibits many of Pablo Picasso's works and paintings that the Spanish artist collected. The Musée d'Orsay houses works of art from the 1800's, especially impressionist paintings. The museum is a converted railway station built in 1900.

The Army Museum is one of the world's largest military museums. It has outstanding collections of historical weapons and armour. Nearby is the tomb of Napoleon I. The tomb stands on the grounds of the Hôtel des Invalides (Home for Disabled Soldiers), completed in 1676. The Cluny Museum, a house built in the 1400's, has art works and other objects of the Middle Ages. The Carnavalet Museum, a house dating from the 1500's, has displays that tell the history of Paris.

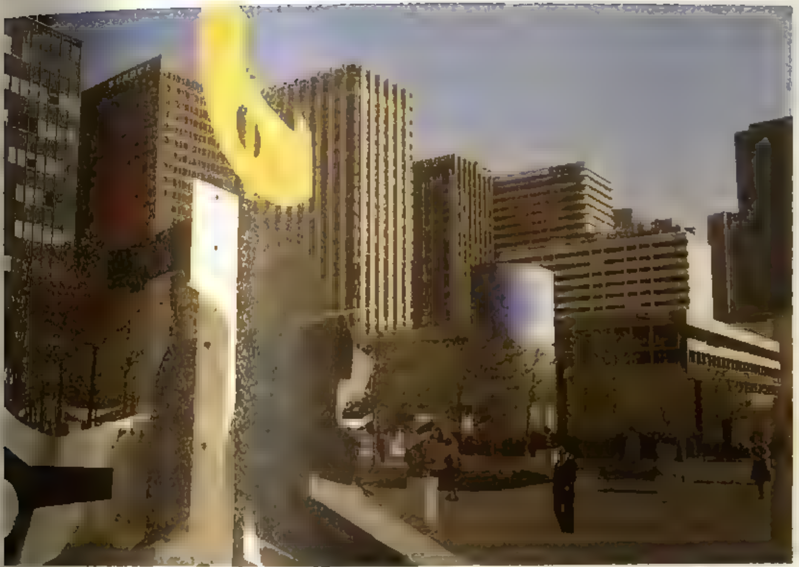
**Schools and libraries.** The University of Paris dates from the 1100's. It developed in an area on the Left Bank that has been called the Latin Quarter since the Middle Ages. At that time, the students and teachers who lived there spoke to one another in Latin. Today, the university has 13 units in the city and its suburbs (see **Paris, University of**). The world-famous École des Beaux-Arts (School of Fine Arts) is also in Paris. It offers courses in drawing, engraving, painting, and similar subjects (see **École des Beaux-Arts**). Other Paris schools include the College of France and the Polytechnical School.

The Bibliothèque Nationale, France's national library, is one of the largest libraries in Europe (see **Bibliothèque Nationale**). Other important Paris libraries include the Mazarine Library of the Institute of France, the nation's major learned society, and libraries of the University of Paris.

**Economy.** Paris is the principal financial, marketing, and distribution centre of France. Many company headquarters and banks and other financial institutions operate in the city. Over half the country's business is done in Paris. Jobs provided by the national and local governments contribute greatly to the city's economy. Paris and its surrounding area make up the country's major manufacturing centre. The Paris region is the centre of the great French car industry. Other important Paris industries include book publishing and the manufacture of chemicals, dyes, electronic machinery, furniture, leather goods, and railway and aeroplane equipment. Paris has long been a world centre of such luxury goods as expensive jewellery, perfume, and women's high-fashion clothing. These famous *articles de Paris* are produced in many small plants in the heart of the city. They are sold in fashionable shops on the Right Bank.

Paris is the transportation centre of France. The national railway network forms a cobweb pattern, with most lines extending from Paris in all directions. Three major airports serve Paris—Charles de Gaulle, Le Bourget, and Orly. The Paris underground railway, called the Métro, has more than 160 kilometres of track. The Regional Express Network is a suburban commuter train system that links the western, eastern, and southern suburbs with Paris. The trains travel at about 95 kilometres per hour.

Paris has about 10 daily newspapers. They account for about a third of the circulation of all French dailies. The



**La Défense**—a building complex with apartments, offices, and other facilities—stands on the western outskirts of Paris. Modern sculptures, as well as trees and fountains, decorate the complex's large pedestrian precinct. La Défense has some of the tallest buildings in the Paris area.

largest Paris paper, *France-Soir,* has a daily circulation of more than 800,000 copies. *Le Monde,* another Paris paper, is world famous. Six major television networks and nine radio networks also operate from Paris. Almost half of them are government-owned.

**Government.** A mayor serves as the head of government of Paris. A city council of 109 members makes the city's laws. The council members are elected by the people to a six-year term. The council members then elect the mayor to a six-year term. Paris is divided into 20 local government units called *arrondissements* (wards or districts). A commission handles the government affairs of each *arrondissement.*

From the 1870's until 1977, prefects appointed by the national government headed the government of Paris. In 1977, a mayor became the head of government.

## History

**Early years.** In ancient times, a Celtic tribe called the Parisii lived in what is now Paris. The Parisii occupied an island in the Seine River. The island is now called the Île de la Cité. In 52 B.C., Roman invaders established a colony there and called it Lutetia. The town soon spread out onto both banks of the river. It became known as Paris in about A.D. 300.

Clovis, the first ruler of the great Frankish kingdom, made Paris his capital in 507. Hugh Capet, the count of Paris and duke of the surrounding region, became king of France in 987. As the French kings gained power, the capital grew in importance and population. Philip II, who ruled from 1180 to 1223, developed Paris as a centre of culture, government, and learning.

**The Renaissance.** The French kings further developed the culture and beauty of Paris during the Renaissance, a revival of art and learning that lasted from the 1300's to the 1500's. The people they employed to design the new boulevards, palaces, and squares looked to ancient Greece and Rome for models. The Louvre, a fortress dating from about 1200, was rebuilt as the royal palace during the 1500's. Many French rulers later built additions to the Louvre, and made it the largest palace in the world. Paris was the centre of the French Revolution (1789-1799). See **French Revolution.**

**The 1800's.** During the early 1800's, Napoleon Bonaparte built many new buildings, laid out public gardens, and made other improvements in Paris. Napoleon III, emperor from 1852 to 1870, did much to give Paris its present appearance. He built banks, hospitals, railway stations, theatres, and wide avenues.

During the Franco-Prussian War (1870-1871), Paris surrendered to Prussian troops after a hard siege in which the city's food supplies were cut off. The starving Parisians ate cats, dogs, and rats to stay alive. See **Franco-Prussian War.**

**The 1900's.** The Germans did some damage to Paris with long-range guns during World War I (1914-1918) but did not capture the city. In September 1914, the Germans pushed French troops back to the Marne River, about 24 kilometres from Paris. The French held their ground, and taxis from Paris brought out fresh troops. This "taxi army" helped win the First Battle of the Marne, which ended Germany's chances for a quick victory.

German troops occupied Paris during World War II (1939-1945). They broke through the French defences in June 1940 and pushed on quickly to Paris. To save Paris from destruction, the French government declared it an *open city,* an undefended city opened to the enemy. German troops entered Paris without a fight and marched triumphantly down the Champs Élysées. Paris became a centre of French underground resistance. In mid-1944, Allied troops began driving the Germans from France. The Allies freed Paris in August 1944.

**Paris today** is involved in a vast urban renewal programme. The programme was drawn up in 1960, and is scheduled to be completed by the year 2000. At that time, the Paris metropolitan area is expected to have a population of more than 12 million. Old buildings and other facilities that will not be able to serve the future population are being replaced. But old monuments, palaces, and other buildings valuable for their beauty are

being restored. A 1961 amendment required all building owners to sandblast and wash the front of their property. By the mid-1960's, Paris was a gleaming city. Since then, many buildings have been classified as historic monuments, including all those in the historic Marais district of the Right Bank. It is against the law to alter the exterior appearance of these buildings.

During the 1960's, much new construction was started throughout Paris. Many new high-rise buildings went up. The 58-storey Maine-Montparnasse Tower, France's tallest building, was completed in 1973. But many people believed the construction of high-rise buildings detracted from the city's charm. In 1973, the city council passed a 10-storey height limit on new buildings in the heart of the city. High-rise construction shifted to the outskirts of the Paris area.

One of the old facilities that have been removed from Paris was Les Halles, the city's central food market. Its narrow streets and old buildings, in which about 30,000 people worked, could no longer serve the city. In addition, movement to and from Les Halles tied up traffic. The removal was completed in 1974. Most marketing operations were transferred to a wholesale operation at Rungis, a suburb south of Paris. Les Halles was replaced with a shopping and cultural centre called Le Forum des Halles. Four of its five levels are below ground.

By the early 1970's, a new 35-kilometre motorway around Paris had been completed. A north-south motorway opened in 1974, and an east-west motorway was completed in late 1976.

A huge, futuristic complex called La Défense opened in 1978 in the western outskirts. It houses offices, shops, entertainment and sports facilities, and apartments. The Arch of La Défense, the centrepiece of the complex, opened in 1989. Another complex, known as La Villette, is on the northern outskirts of Paris. A museum called the Science and Industry Centre, an exhibition hall, and part of a park opened there in the 1980's. A music conservatory was completed there in 1990. A theme park called Euro Disneyland opened in 1992 in the Paris suburb of Marne-la-Vallée.

Efforts to improve and beautify Paris have resulted in a rapid rise in property values. As a result, many poor and middle-class people have moved to the suburbs.

**Related articles** in *World Book* include:

Arc de Triomphe
Bastille
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École des Beaux-Arts
Eiffel Tower
France (pictures)
French Revolution
July Revolution (picture)
Louvre
Notre Dame, Cathedral of
Obelisk
Paris, University of
Seine River
Sorbonne
Tuileries

**Outline**

**I. City**
- A. Gardens, squares, and parks
- B. Famous buildings
- C. Arts
- D. Museums and art galleries
- E. Schools and libraries
- F. Economy
- G. Government

**II. History**

**Questions**

Why is Paris called the *City of Light*?
Where in Paris is the Cathedral of Notre Dame?
What official heads the government of Paris?
What are the Left Bank and the Right Bank of Paris?
What did the ancient Romans call the Paris area?
When did Paris receive its present name?
What is Paris' highest hill? What is at its top?
What is the Eiffel Tower? Panthéon? Champs Élysées?
How did the Latin Quarter receive its name?
How was Paris saved from damage in World War II?

**Paris, Comte de** (1838-1894), a claimant to the French throne, became heir apparent on the death of his father in 1842. But he lost his rights when his grandfather, King Louis Philippe, was driven from the throne in the Revolution of 1848.

The count served briefly as a captain of volunteers in the Union Army during the American Civil War. After the fall of Napoleon III in 1870, he returned to France. He became the candidate of the *royalists,* those who favoured a return to government by kings. But the suspicious French Republicans passed an Act of Expulsion in 1886, which forced the count into permanent exile in England.

The count was born in Paris, and was educated in England. His full name was Louis Philippe Albert d'Orléans.

**Paris, Matthew** (1200?-1259), was an English monk and historian. He entered the monastery of St. Albans in 1217, and from 1235 until his death continued the *Chronica Maiora* (*Greater Chronicle*), which had been begun by Roger of Wendover. The *Chronica Maiora* is an important source-book on the early history of England. The information that Paris gives about England in his own time often came from the first-hand accounts of the many nobles and scholars who visited St. Albans. Paris' acquaintance with King Henry III gives added interest to his record of affairs of state in England during the mid-1200's.

**Paris, Pact of.** See **Kellogg-Briand Peace Pact.**

**Paris, University of,** is a government-supported university system in Paris and its suburbs. It consists of 13 units called the University of Paris I, II, III, and so on. The university is coeducational and has more than 296,000 students, of whom about 51,000 are from other countries. The university offers courses in economics, law, liberal arts, science, and many other fields. Each unit specializes in a group of subjects. For example, the University of Paris V concentrates on medicine and on pharmaceutical and biological sciences. Students attend lectures and participate in discussion groups.

The University of Paris, one of Europe's oldest universities, was organized during the 1100's. It became known as the Sorbonne, which was the name of its most famous college (see **Sorbonne**). In 1968, the government passed a law to reform higher education. As a result of this law, the university was reorganized in 1970 into the 13-unit system.

See also **Education** (picture); **University.**

**Paris conferences.** Many international conferences have met in Paris, France. But the term Paris Conference usually refers either to the Paris Peace Conference of 1919 or to the Paris Conference of 1946.

After World War I (1914-1918), representatives of 32 Allied nations met in Paris in January 1919, to draw up terms of peace with Germany and its allies. German representatives were not allowed to take part in the conference. They were called to Paris in April. The treaty was

signed in June in the Palace of Versailles. See **Versailles, Treaty of.** In July 1946, after World War II (1939-1945), delegates from 21 nations met in Luxembourg Palace in Paris to consider draft peace treaties with Italy, Hungary, Bulgaria, Romania, and Finland.

**Parish** is the smallest administrative unit of the Church of England. It is also a division of a *district* (unit of local government) in England. An ecclesiastical parish is an area that has its own church and minister. It is a subdivision of a *diocese.* There are about 13,600 ecclesiastical parishes in England. The parish of local government was established by act of Parliament in 1894, and generally followed the boundaries of the ecclesiastical parish.

**Parity,** in physics, concerns the symmetry between an event and its reflection in a mirror. The idea of parity is a useful tool in quantum mechanics. Physicists say that *parity is conserved* when an event and its mirror image both satisfy laws of nature. In this case, an observer cannot tell the difference between the event and its reflection. The same laws apply to the event and its image, and give the observer no clue by which to identify one or the other. Parity is conserved in all ordinary mechanical and electrical systems.

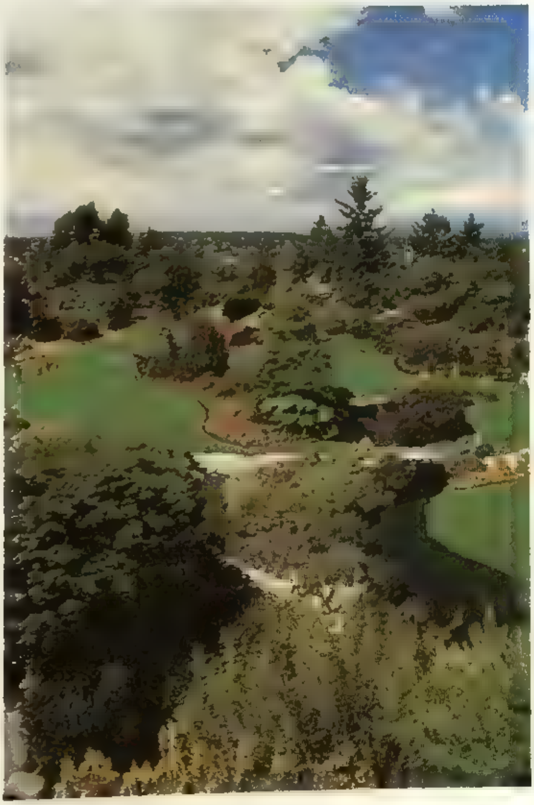
Physicists once believed that the conservation of parity was a natural law that applied to all events. But in 1956, two Chinese-born physicists, Tsung Dao Lee and Chen Ning Yang, suggested a number of experiments which proved otherwise. The experiments showed that parity was not conserved in a type of nuclear event called a *weak interaction.* An example of a weak interaction is the emission of an electron by a radioactive nucleus.

The first such experiment was performed at the United States National Bureau of Standards by C. S. Wu of Columbia University, New York City and E. Ambler, R. W. Hayward, D. D. Hoppes, and R. P. Hudson of the Bureau who used atoms of the radioactive cobalt-60. The result of their experiment showed that parity conservation is not a universal law of nature.

**Park.** Most parks are pieces of land set aside for the public to enjoy. Many parks are used for recreation or as places where visitors can relax in a natural environment. Some parks are used for cultural and educational events, sports, rallies, and festivals. Parks range in size from *urban* (city or town) parks of less than a hectare in area, to *national parks* covering vast areas of wilderness and unspoiled countryside (see **National parks**). This article deals mainly with urban parks.

Local, regional, or national governments administer parks and park systems in many countries of the world. There are also privately owned parks, to some of which the general public are admitted. For information on amusement parks and theme parks, see the article **Theme park.**

The most familiar kind of park is the urban park, run by the parks department of the local council or other local authority. This type of park provides greenery and open space, adding variety to city and town landscapes. Many urban parks have picnic areas, and some have nature trails and tracks for horseriding, jogging, or walking. Some urban parks also have zoos and facilities for tennis and other sports. At many lakeside parks, visitors may swim, sail, or row a small boat. A few parks are venues for outdoor music concerts.



**Parks** are places of relaxation and recreation for people all over the world. Queen Elizabeth Park, in Vancouver, Canada, *above,* is famous for its arboretum, where visitors can see trees and shrubs in their natural environment. Regents Park, London, *left,* opened in the 1800's, later contained London Zoo. It boasts an open-air theatre, a boating lake, and attractive expanses of greenery. Regent's Park was named after George IV when he was Prince Regent.

**Central Park** in New York City was laid out in the 1800's. It was designed to create a rural atmosphere in the city centre.

In addition to local, urban parks, some countries have larger, state parks. In Canada, these parks are called *provincial parks.* These are large areas of land closer in size to national parks than to urban parks. Many state and provincial parks have been set aside to preserve spectacular mountains or lakes, dense forests, unusual wildlife, or historic monuments.

**History.** Some experts believe that the ancient Sumerians of Mesopotamia (now Iraq) created the first parks during the 2300's B.C. Many early parks, especially those of the ancient Persians, contained hunting areas or elaborate gardens. Most of these parks belonged to wealthy royal or private landowners, for their own enjoyment. The first public parks were probably opened in Greece. The Agora in Athens was an early example of a city park. It was used for public speeches and political debates and also for physical exercises.

By the A.D. 1200's, small public parks had become common in European cities. From the 1500's, many great houses were surrounded with parkland laid out by expert landscape architects. Many parks also had extensive wooded areas and *vistas* (views), and enclosures or cages for birds and wild animals.

From the 1600's, public parks became beautiful green spaces where people could relax. Originally, these open areas, which often boasted tree-lined paths and fountains, were the focal points of cities. Examples include the pleasure gardens at Vauxhall, in south London, which opened in the 1650's and Boston Common, in Boston, Massachusetts, U.S.A., which opened in 1664 and was the first public park in America. In the 1800's and 1900's, parks became places where people could escape from the traffic and noise of cities. Famous public city parks of the 1800's include London's Regent's Park, designed by John Nash; New York City's Central Park, designed by Frederick Law Olmsted and Calvert Vaux; and the Royal Botanic Gardens in Melbourne.

London is also famous for its royal parks, St. James's Park, Green Park, Hyde Park (with its well-known lake, the Serpentine), and Kensington Gardens.

See also **National parks; Landscape architecture; Recreation.**

**Park, Mungo** (1771-1806), a Scottish surgeon and explorer, was the first European to trace the course of the Niger River in western Africa. In 1795, with two companions, he journeyed overland from the basin of the Gambia River to the Niger, suffering grave hardships along the way. He followed the river downstream until he satisfied himself that it flowed eastward. Then he returned to the Gambia region.

Park's account of his journey was published in 1799. He returned to Scotland and took up medical practice in Peebles. In 1805, the government sent Park back to Africa to discover if the Niger flowed into the Gulf of Guinea. On this expedition, Park took a surgeon, a draughtsman, and a group of soldiers. Fevers and tropical diseases killed most of the members of the expedition before they reached the Niger. Park and the rest were killed when Africans attacked their boat.

Park was born at Foulshiels, Borders Region, in Scotland. He studied medicine at Edinburgh.

**Park, National.** See **National parks.**

**Park, Ruth** (1923- ), an Australian author, won the Miles Franklin award for her novel *Swords and Crowns and Rings* in 1977. Her other novels include *The Harp in the South* (1948), *Poor Man's Orange* (1949), *The Witch's Thorn* (1951), *A Power of Roses* (1953), *Pink Flannel* (1955), *One-a-Pecker, Two-a-Pecker* (1957), and *The Good Looking Woman* (1961). The most familiar of her children's books are those in the Muddle-Headed Wombat series, which originated in scripts for a children's radio programme. Another well-known novel that Park wrote for teenagers, *Playing Beattie Bow* (1980), was made into a film in 1986. Rosina Ruth Lucia Park was born in Auckland, New Zealand. She moved to Sydney, Australia, in 1942 and married the writer D'Arcy Niland. After his death she moved to Norfolk Island.

**Park Chung Hee** (1917-1979) served as president of South Korea from 1963 to 1979. He had taken power as head of the nation in 1961 after leading a military revolt against the civilian government. In 1979, Park was assassinated by the head of the country's Central Intelligence Agency.

**Park Chung Hee**

Park, a controversial leader, helped establish many new industries in South Korea and the country's economy grew rapidly under his rule. On the other hand, Park's government greatly restricted individual rights. For example, the government made

it illegal to criticize the president or the constitution, which gave the president great power. Park had many people imprisoned for criticizing his policies. He said harsh rule was needed to guard against attack by North Korea (see **Korea** [North-South relations]).

Park was born in Sonsan-gun, a county in North Kyongsang Province, South Korea. In the early 1940's, he attended military academies and served in the Japanese Army. He entered the Korean Military Academy in 1945. Park became a Korean Army captain in 1946 and a general in 1953. After leading the 1961 military revolt, he headed a military government for two years. In 1963, Park resigned from the army and was elected president by the people to head a new civilian government. He was reelected by the people in 1967 and 1971. In 1972 and 1978, Park was reelected by an electoral college made up of people who remained loyal to him.

**Parker, Lord** (1900-1972), Hubert Lister Parker, became lord chief justice of England in 1958. He was made a member of the Privy Council in 1954 (see **Privy Council**). Lord Parker was born at Haslemere, in Surrey, England. He was educated at Rugby School, Warwickshire, and Cambridge University. He was called to the Bar in 1924. In 1934, he became junior counsel in common law to the Admiralty. He was appointed a judge of the King's Bench Division of the High Court in 1950 and a lord justice of appeal in 1954. Lord Parker was knighted in 1950. See **Court**.

**Parker, Charlie** (1920-1955), an American alto saxophonist and composer, ranks among the most influential musicians in jazz history. Parker and trumpeter Dizzy Gillespie were responsible for the rise of *bebop*, a complex rhythmic, melodic, and harmonic form of jazz that developed in the 1940's. His many recordings illustrate his amazing technique and the richness of his musical ideas. Several of his compositions, including "Ornithology" and "Confirmation," became jazz standards. And his improvisations brought new life to other composers' works.

**Parkes radio telescope** is one of the most accurate and versatile radio astronomical instruments in the world. It was used to pinpoint the mysterious quasars in 1962.

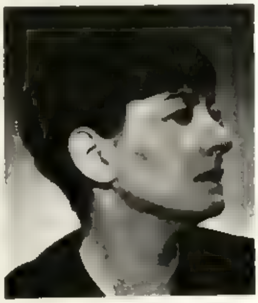
Charles Christopher Parker, Jr., was born in Kansas City, Kansas, U.S.A. He was nicknamed "Bird." He worked in the bands of Jay McShann, Earl Hines, and Billy Eckstine before forming his own small groups in the 1940's. His music influenced many other musicians. As a result of heroin addiction, he suffered from many physical and emotional ills during his last years.

See also **Jazz** (Bop and cool jazz).

**Parker, Dorothy** (1893-1967), was an American poet and short-story writer. She also won fame for her witty conversation and literary criticism.

Most of Parker's verse and stories express a humorous but cynical disappointment with life. She often wrote in a biting, ironic style about the loss of love and idealism. Her precise use of language gives her writing a crisp, conversational tone. One of her most quoted poems, "News Item" (1926), observes that "Men seldom make passes/At girls who wear glasses." Parker's poetry was published in *Enough Rope* (1926), *Sunset Gun* (1928), and *Death and Taxes* (1931).

In her short stories, Parker examined the hypocrisy of modern society while showing compassion for its victims. *Here Lies* (1939), a collection of these stories, includes such works as "Mr. Durant" (1924) and "Big Blonde" (1929).



**Dorothy Parker**

Parker began her literary career in 1916 as a writer for a women's magazine. In 1925, she became one of *The New Yorker* magazine's first regular contributors. She wrote for the magazine's book review column for several years. Parker's book reviews were published in *Constant Reader* (1970), a book named after the title of the column.

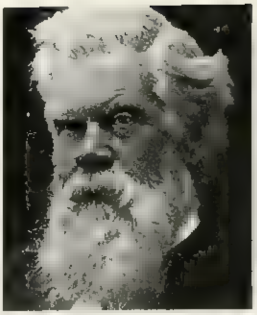
During the 1920's, Parker belonged to the Algonquin Round Table, a group of famous writers who met regularly at the Algonquin Hotel in New York City. She became known for her quick-witted quips. For example, when told that the solemn President Calvin Coolidge had died, she asked, "How could they tell?"

Dorothy Rothschild Parker was born in West End (now part of Long Branch), New Jersey, U.S.A., and spent most of her life in New York City. She wrote under her married name, though she divorced Edwin Pond Parker in 1928.

**Parkes** (pop. 13,901) is a town in central western New South Wales, Australia, about 370 kilometres west of Sydney. It is the site of the Australian National Radio Astronomy Observatory, operated by the Commonwealth Scientific and Industrial Research Organization. The observatory includes a 64-metre radio telescope, which has helped astronomers make notable advances in their investigation of the universe.

The telescope was opened in 1961. In 1962, astronomers used the telescope to pinpoint the first of the far distant mysterious groups of stars called *quasars*. The telescope was also involved in the Halley's Comet-Giotto spacecraft encounter in March 1986.

**Parkes, Sir Henry** (1815-1896), served as premier of New South Wales, Australia, on five occasions, between 1872 and 1891. He served as a member of Parliament for 40 years. The Australian states did not form a federation until 1901, after Parkes' death. But as one of the prime movers towards federation, Parkes is often called *the father of federation.* He presided over the First Federal Convention held in Sydney in 1891. This convention provided the basis for the next ten years of discussion and negotiation between the states. Sir Henry Parkes, with Alfred Deakin, suggested the name *Commonwealth of Australia,* which was eventually adopted.


**Sir Henry Parkes**

**Early life.** Henry Parkes was born on May 27, 1815, at Stoneleigh in Warwickshire, England. He was the youngest of seven children. His father was a tenant farmer on an estate called Stoneleigh Abbey. When Henry was about seven, his father had to give up his tenancy. The family was forced to look for employment in Birmingham. These were difficult times, and everyone in the family had to go to work. Henry had little formal schooling. But he did learn to read and write and came to enjoy poetry and drama, particularly that of William Shakespeare. Later, he wrote poetry himself and had several volumes of verse published.

In his teens, Parkes was apprenticed to a craftsman who worked in bone and ivory. In 1836, he completed his apprenticeship and married Clarinda Varney. He and his wife first looked for work in London. But jobs were hard to find and they decided to emigrate to New South Wales. They arrived in Sydney in 1839. At first, the only work Parkes could find, was as a labourer in the country. But after some months, he succeeded in finding work in Sydney. During the 1840's, Parkes held a number of jobs. For a time, he served as a clerk in the colonial customs department. In 1845, he left customs and opened a small business of his own. He first showed an interest in politics in the late 1840's. At that time, he took a leading part as a speaker in the movement to stop the renewed transportation of convicts from Britain to Australia. In 1853, Parkes abandoned his craft as a tradesman. With the backing of a number of friends, he became the proprietor and editor of a newspaper called the *Empire.*

**Member of Parliament.** Parkes was elected to the Legislative Council (the Upper House) of New South Wales in 1854. He moved to the Legislative Assembly in 1856. His newspaper accumulated debts and failed in 1858. In 1861, Parkes accepted a government post in England. There he worked to encourage immigration to New South Wales. He returned to New South Wales in 1863. In 1866, he became a minister for the first time in the government of prime minister James Martin. He was instrumental in having Florence Nightingale send nursing sisters to Sydney to reorganise the colony's hospitals.

**Premier.** Henry Parkes became premier of New South Wales for the first time in 1872. In all, he was to be premier of the state five times.

As premier of New South Wales, Parkes was responsible for passing legislation that brought important changes to Australia. In 1866, and again in 1880, he introduced Education Acts. These acts instituted a system of free compulsory schooling under the supervision of state boards responsible to a minister. In 1891, following the recommendations of a Royal Commission into a maritime strike, Parkes introduced legislation to provide for conciliation and arbitration of industrial disputes. This was the first act of its kind in the Australian colonies. In 1882, while premier, Parkes visited England, travelling by way of the United States.

Soon after his return, his government was defeated. His business ventures still were not going well, and in 1887 he was declared bankrupt for the third time. But in that same year, he became premier again. He held office, with one small break, for the next five years. During this period, Parkes became deeply involved in the issue of federation. He was also involved with an act that prohibited Chinese immigration.

Parkes' wife, Clarinda, died in 1888. They had been married for 52 years. Despite his personal problems, Parkes opened the campaign for federalism in 1889, giving a great speech at Tenterfield. A number of events helped further the movement towards federalism. For one thing, the European powers at that time all sought to acquire overseas possessions. Also, the Australian colonies had been made aware of how ill-prepared they were to defend themselves. A visiting British army officer had written a report, recommending that Australia develop a national army. Parkes had argued for federalism for the past 20 years.

The first national convention to draft a constitution met in Sydney in 1891. Parkes served as president of the convention, acting with great dignity. But he left the more detailed work of drafting to younger people. In 1891, he gave up the premiership because of his age and because he had broken his leg in a serious accident. He remained active in politics for some years. But he became increasingly bitter at his ill fortune.

In 1894, Parkes made an attempt to resume his political career. At nearly 80 years of age, he emerged from retirement to found a *Federal Party.* But this effort did not succeed. Parkes' personal misfortunes continued with the death of his second wife, Eleanor Dixon, whom he had married in 1889. He was left with a young family and limited means of support. Parkes married a third time. His new wife, Julia Lynch, cared for him and for his children. Parkes died on April 27, 1896.

See also Federation of Australia.

**Parking meter.** See Traffic (Parking meters).

**Parkinson, C. Northcote.** See Parkinson's law.

**Parkinson, Cecil** (1931-     ), a British Conservative Party politician, became minister of transport in 1989. He resigned from this cabinet post in 1990. He was made a life peer in June 1992. He had been secretary of state for energy since 1987, and was secretary of state for trade and industry from June to October 1983.

Parkinson was born at Carnforth, Lancashire, England and educated at Lancaster Grammar School and at Emmanuel College, Cambridge University. He began a business career in 1956. He became a member of Parlia-

ment in 1970. Parkinson was Chancellor of the Duchy of Lancaster from 1982 to 1983.

**Parkinson's disease** is a disorder of the brain that reduces muscle control. Most cases affect people from 50 to 70 years old. The disease is named after the English doctor James Parkinson, who in 1817 first described it. Symptoms include trembling hands, rigid muscles, slow movement, and balance difficulties.

The cause of Parkinson's disease is unknown, although it is believed that environmental toxins such as pesticides may play a role. The symptoms of the disease are associated with the destruction of nerve cells in a certain region of the brain. The loss of these cells results in a loss of *dopamine*, a chemical that the nerve cells use to communicate with the rest of the brain.

The symptoms of the disease develop gradually, often with trembling in a hand. For this reason, Parkinson's disease used to be called *shaking palsy*. Symptoms usually begin on one side of the body and spread to the opposite side. A person with the disease often walks with a shuffle and finds it hard to write clearly and button up clothes. Rigid muscles in the face may cause a fixed, masklike expression. The disorder can cripple a victim but rarely causes death.

Parkinson's disease is treated mainly by replacing the lost dopamine with a drug known as *levodopa*, or *L-dopa*. However, long-term use of this drug can lead to complications. Complications include abnormal movements, abrupt changes in muscle control, sleeplessness, vivid nightmares, hallucinations, and confusion. Other drugs used in the treatment of Parkinson's disease also have unwanted side-effects.

In the late 1980s, a new drug became available for treatment of advanced Parkinson's disease. The drug, *deprenyl*, not only alleviates the symptoms but also seems to halt progress of the disease.

In some cases, the symptoms of Parkinson's disease can be related to a specific cause. When this occurs, the group of symptoms is known as *parkinsonism* and not Parkinson's disease. Specific causes for parkinsonism include the use of certain drugs and exposure to toxic chemicals.

In 1983 symptoms of the disease were found in young people who had been using contaminated heroin traded in northern California. The contaminant was MPTP, one of the pyridine group of chemicals, which is converted to a neurotoxin (destroyer of nerve cells) in the brain. Now that MPTP has been implicated in Parkinson's disease, the substance itself is being used in experiments to find a cure for the disease.

**Parkinson's law** is a humorous criticism of the administration of business or government. This "law" is based on the idea that "work expands so as to fill the time available for its completion." The law states that the number of administrators increases, whether or not their official responsibilities increase. Such growth supposedly occurs because these officials create assistants. These assistants, in turn, create new work.

C. Northcote Parkinson, a British historian, developed the law in 1957 in his book *Parkinson's Law and Other Studies in Administration*. He applied his law to government administration. But today, people use it to explain almost any situation in which the number of staff increases faster than the work to be done.

Parkinson supported his law with statistics. For example, he found that the number of administrative officials in the British navy increased 78 per cent from 1914 to 1928. But during that same period, Great Britain reduced its fleet about 68 per cent.

**Parkman, Francis** (1823-1893), one of America's greatest historians, wrote vivid accounts of the role of the Indians in North American history. He made a famous journey on the Oregon Trail in 1846, and lived with the Indians for months to gather material for a book. Published in 1849 as *The California and Oregon Trail*, it later became famous as *The Oregon Trail*. Parkman also made a thorough study that included five trips to Europe for material before he published *History of the Conspiracy of Pontiac* (1851).

He also wrote *France and England in the New World*, a seven-volume series. These books described the history of the struggle between France and Great Britain for control of North America, and the part the Indians played in it. The series included *Pioneers of France in the New World* (1865), *The Jesuits in North America* (1867), *The Discovery of the Great West* (1869), and *Montcalm and Wolfe* (1884). Parkman's books did not include the economic elements of history now considered important, but they were so realistically written that they still may be read with great pleasure.

Parkman was born in Boston Massachusetts, U.S.A. He graduated from Harvard, and later studied law there. He was elected to the United States Hall of Fame in 1915.

**Parks, Rosa Lee** (1913- ), is a black woman who refused to give up her seat to a white passenger on a bus in Montgomery, Alabama, U.S.A. Her refusal, which occurred in 1955, helped bring about the civil rights movement in the United States.

Parks, a seamstress, was arrested for violating a city law requiring that whites and blacks sit in separate rows on buses. She refused to give up her seat in the middle of the bus when a white person wished to sit in her row. The front rows were reserved for whites only. The law required blacks to leave middle rows when all seats in the front rows were taken and whites wanted to sit in the middle.

Blacks staged a year-long boycott of the Montgomery bus system to protest against Parks's arrest. The boycott was led by Martin Luther King, Jr., who called for an end to segregation on buses.

The success of the Montgomery boycott, which made King widely known, led to mass protests demanding civil rights for blacks. Parks is sometimes called the mother of the modern civil rights movement. In 1979, Parks won the Spingarn Medal for her work in civil rights.


Rosa Lee Parks

Parks lost her job as a result of the Montgomery protest. She moved to Detroit in 1957. In 1967, she joined the Detroit staff of John Conyers, Jr., a Democratic member of the U.S. House of Representatives. Parks was born in Tuskegee, Alabama, U.S.A.

**Parliament** is the national lawmaking body of Australia, Canada, Japan, the United Kingdom (UK), and other democratic countries. Some parliaments are made up entirely of elected representatives. Others have both elected and appointed or hereditary members.

In a parliamentary government, the top officials are known as *ministers* (heads of government departments). They make up an executive body called the *cabinet.* They are also members of parliament, and so they carry out legislative functions as well. The top officials are elected by the voters of the district that they represent, rather than by the entire nation. However, the cabinet functions under the control of the parliament.

In most countries with parliamentary government, the chief executive is called the *prime minister.* The prime minister is the leader of the largest party in parliament or of a *coalition.* A coalition is a temporary joining of parties that together have a majority of seats. The prime minister is formally appointed by the official head of state, rather than elected by the voters. The official head of state may be the king or queen of a monarchy or the president of a republic.

In most parliamentary governments, the prime minister chooses members of his or her own political party to become ministers. The most important ministers belong to the cabinet. Parliamentary government is also called *cabinet government,* because control rests with the cabinet.

Members of parliament are elected to a maximum term of office. At the end of the term, an election must be held. But a general election may occur at any time short of a full term. For example, the cabinet may resign and a new election be held if parliament defeats a programme the prime minister considers essential. An election also must occur if parliament votes "no confidence" in the cabinet.

## The United Kingdom Parliament

The UK Parliament, which has been called "the mother of parliaments," does not obtain its authority from a written constitution. Instead, Parliament's power is based on tradition and custom as well as written law.

Parliament consists of the *monarch* (king or queen); the House of Commons, often called simply the *Commons;* and the House of Lords, often called simply the *Lords.* In everyday conversation, however, the term *Parliament* means just the Commons and the Lords. The power of the Commons greatly exceeds that of the monarch or of the Lords. Although the monarch officially has the power to reject legislation passed by Parliament, no ruler has done so since the early 1700's.

**The House of Commons** is the real governing body of the UK, though it is called the *lower house* of Parliament. The term *lower house* refers to the branch of a lawmaking body considered closer to the people. The Commons, like most lower houses, consists of representatives who are elected by popular vote.

The House of Lords may delay, but not defeat, legislation passed by the Commons. *Money bills* (bills concerned solely with imposing taxes or authorizing the spending of public money) passed by the Commons become law within one month, even without approval of the Lords. Nonmoney bills passed by the Commons in two consecutive sessions automatically become law a year after the second passage.

The House of Commons has 651 members—524 from England, 38 from Wales, 72 from Scotland, and 17 from Northern Ireland. The prime minister and most Cabinet ministers are members of the Commons. Each member represents a voting district called a *constituency.* Members are not required to live in the constituency they represent. Clergy of the Church of England, the Church of Scotland, the Church of Ireland, and the Roman Catholic Church cannot be elected to the Commons. Members of the nobility—except Irish peers—and certain government officials also are ineligible.

Members of the House of Commons receive an annual salary. They also receive allowances for travel and for administration, such as the cost of employing a secretary.

**How members are elected.** Members are chosen in a *general election,* in which all voters may participate. If a member dies or resigns, the constituency chooses a new representative in a *by-election.*

**The Commons Chamber,** *left,* is the room where the House of Commons meets. It was rebuilt after a German air raid destroyed it in 1941, during World War II. It reopened in 1950. The Government members sit on the left, and the Opposition members on the right.

Members are elected to a maximum term of five years, after which Parliament must be dissolved and another election held. However, an election may be called at any time, and most Parliaments *sit* (are in session) for less than five years. The prime minister may call for a new election if Parliament refuses to support the policies of the Cabinet or if he or she believes the political climate favours another victory by his or her party.

**How the House of Commons works.** The House of Commons sits for about 160 days annually from November to October. Most sessions last from mid-afternoon to evening, though some continue through the night.

The Commons meets in a long room, called *the chamber*, with rows of benches running along two sides. The speaker of the House of Commons sits at one end of the chamber. The speaker presides over the sessions, grants members the right to speak, and keeps order during debates. Members of the prime minister's party, representing the *government*, sit on the benches to the speaker's right. Members of other political parties supporting the government also sit on that side of the room. Members of the second largest party, called the *opposition*, and their supporters sit to the left of the speaker. The leaders of the government and the opposition are known as the *front bench* because they sit on the benches nearest the centre of the chamber. Other members sit behind them and are known as the *back bench*.

The government and the opposition debate most proposed legislation. Other discussion between the two sides takes place at the question periods at the opening of the order of business. Members of the opposition question the prime minister and other members of the government about their policies.

**The House of Lords** is called the *upper house* of Parliament, though it has less power than the House of Commons. The term *upper house* refers to the branch of a lawmaking body that is less subject to control by the voters. This house, for example, is not an elected assembly. Most of its members inherit their seats.

The main function of the Lords is to review legislation passed by the Commons. Although the Lords can amend bills, it rarely changes their basic principles. The Lords also serves as the highest court of appeal.

The House of Lords has about 1,170 members, including about 800 *hereditary peers and peeresses*, about 320 *life peers and peeresses*, about 20 *law lords*, and 26 *lords spiritual*. Hereditary peers and peeresses are members of the nobility who have inherited their seats. Life peers and peeresses are appointed to the Lords to honour their achievements in business, civil service, or other fields. They have the title of baron or baroness. Law lords, also called *lords of appeal* are chosen from among Britain's highest-ranking judges. They form the final court of appeal for civil cases throughout Great Britain and for criminal cases in England, Wales, and Northern Ireland. Lords spiritual are senior members of the Church of England. Life peers, law lords, and lords spiritual are appointed to their seats for life. Their children do not inherit their seats.

Only about 20 per cent of the members attend most debates in the House of Lords. Members are not paid a salary, but they do receive travel expenses.

**The Houses of Parliament.** Parliament has met on the same site in London since 1547. For almost 300 years, it met in St. Stephen's Chapel in the Palace of Westminster. A fire destroyed that building in 1834. The present Houses of Parliament, completed in 1860, are known officially as the New Palace of Westminster. In 1941, during World War II, a German bomb demolished the meeting chamber of the House of Commons. The present chamber was completed in 1950.

**History.** The UK Parliament developed from a council of nobles and high-ranking clergy that advised the early kings of England. After the Norman Conquest in 1066, this informal advisory group became a formal assembly called the Great Council. It met three times yearly to help the king decide policy and make laws.

**The Lords Chamber,** *left,* where the House of Lords meets, was first occupied in 1847. The cushioned benches on the left form the main seating area for Government members, and the benches across the aisle are for the Opposition members.

During the early 1200's, King John began to call knights elected from the *shires* (counties) to some meetings of the Great Council. He summoned the knights to obtain their approval of taxes he had levied, because tax collection would be difficult without their cooperation. In the mid-1200's, the English statesman Simon de Montfort enlarged the council, by then called Parliament, to include elected representatives from towns, shires, and boroughs. The meeting King Edward I called in 1295 became known as the *Model Parliament,* because it resembled later Parliaments.

By the mid-1300's, the elected representatives began to meet separately from the nobles and bishops, and Parliament was divided into two houses. By the late 1300's, the Commons obtained the right to consider tax legislation before it was discussed by the Lords. However, the Commons had no power to initiate legislation. It could only ask the monarch to grant requests. By the early 1400's, the Commons gained the right to introduce bills.

**Parliament gains strength.** As its role in government increased, Parliament demanded greater power. During the 1620's, the struggle between Parliament and the king became bitter. In 1628, Parliament forced King Charles I to sign the Petition of Right, a document that limited royal power. However, Charles refused to obey the agreement. He did not allow Parliament to meet from 1629 until 1640, when he was forced to call a meeting to obtain funds. But Parliament refused to provide any money unless Charles obeyed the Petition of Right. He refused, and civil war broke out. In 1649, Parliament ordered Charles beheaded. The legislature, led by the Puritan general Oliver Cromwell, declared England a republic and ruled until 1653. Because the same Parliament had remained in session since 1640, it became known as the *Long Parliament.* Cromwell then ruled as a dictator until his death in 1658. In 1660, a new Parliament restored the monarchy.

The Bill of Rights of 1689 established the right of Parliament to meet frequently and to have freedom of speech during debates. It also confirmed the right of the Commons to control financial legislation. By the early 1700's, Parliament had gained nearly total control over the monarchy. In 1707, the Act of Union joined England, Scotland, and Wales together to form Great Britain, and established a single parliament for the nation.

During the 1800's, the membership of Parliament changed dramatically. In the early 1800's, nobles and other wealthy landowners controlled most of the members of Parliament, including members of the House of Commons. Some districts with almost no voters had representation, while some other districts with large populations had none. Few citizens had the right to vote. In 1832, Parliament passed a reform bill which distributed seats on the basis of population. The bill also reduced the property requirements for voting to give most middle-class men, but no women, the right to vote. The Parliamentary Acts of 1867 and 1884 extended the vote to nearly all adult males. In 1928, women received full voting rights.

**The decline of the House of Lords.** During the 1800's, the two houses of Parliament remained nearly equal in power. Although the Commons had control over money bills, the Lords had the power to veto legislation. In 1909, the Lords rejected a budget approved by the Commons. A struggle broke out between the two houses of Parliament, which resulted in the Parliamentary Act of 1911. Under this act, the House of Lords lost its veto power. The Lords could delay money bills for only one month and nonmoney bills for two years. The Parliamentary Act of 1949 reduced to one year the time that the Lords could postpone nonmoney bills.

### Parliaments in other countries

The parliaments of Australia, Canada, and New Zealand greatly resemble the British Parliament. The parliament of Australia, called the *Federal Parliament,* is made up of the Senate and the House of Representatives. Members of both houses are elected. Most bills are introduced in the House of Representatives, which has more power than the Senate does. The Canadian Parliament has two houses—the Senate and the House of Commons. Senators are appointed and have less power than do the elected members of the House of Commons. The New Zealand Parliament consists of one house, the House of Representatives, whose members are elected. India, South Africa, and many other former colonies of the UK also have parliaments.

Japan's parliament, called the *Diet,* has two elected houses. The *Althing* of Iceland, the world's oldest parliament, has existed since A.D. 930.

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Prime minister
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**Parliament, European,** is the directly elected Parliament of the European Union (EU) (see **European Union; Common Market**).

The members of the European Parliament (MEP's) meet in Strasbourg, in France. Sessions are usually held at monthly intervals. The committees of the European Parliament usually meet in Brussels, where the European Union's administration has its headquarters.

The European Parliament has 518 members. The number of members each country has, from largest to smallest number of representatives, is as follows: France, Germany, Italy, and the United Kingdom, 81 each; Spain, 60; the Netherlands, 25; Belgium, Greece, and Portugal, 24 each; Denmark, 16; the Republic of Ireland, 15; and Luxembourg, 6.

**Work and powers.** The European Parliament does not have as much power as the parliament of an individual nation. Only the Council of Ministers, which represents the national governments, has the power to make legislation that affects all the member countries. The executive arm of the EU is the Commission of the European Communities, often called the *European Commission.* The commission must answer the European Parliament's questions and report on its conduct of Union affairs. It must also respond to the Parliament's recommendations on EU business.

In legislation, the role of the European Parliament is largely advisory. The European Commission proposes legislation. Parliament then considers these proposals. Parliament's amendments and opinions must be considered by the Council of Ministers before it decides on legislation. The Parliament has power over part of the EU's budget, and the Council and Parliament must agree on the budget before money can be spent.

**History.** Until 1979, the European Parliament was appointed by the legislatures of the member states. From 1973 to 1979, the United Kingdom's and Ireland's parliaments appointed MEP's from their own ranks. In June 1979, member states of the European Community, as the EU was then called, held the first direct elections for MEP's. Direct elections enabled an MEP to be elected without being a member of a national parliament.

**Parliamentary Commissioner for Administration.** See Ombudsman.

**Parliamentary procedure** is a way to conduct a meeting in an orderly manner. Whenever people hold a meeting, they need rules to help them accomplish their purpose. The rules of parliamentary procedure help the presiding officer keep order during a meeting as well as guide participants in transacting business. The procedure is called *parliamentary* because it comes from the rules and customs of the United Kingdom Parliament. Parliamentary procedure is also known as *parliamentary law, parliamentary practice,* and *rules of order.*

No one knows who first used parliamentary rules. But some such rules must have guided even the oldest governing bodies. Much of parliamentary procedure as we know it developed in the British Parliament. By the end of the 1600's, the broad principles had become well established. As actual procedures developed, they became the basis for deciding later questions of parliamentary law. Many early questions of parliamentary law were collected and published in 1776 and 1781 by John Hatsell, a clerk of the British House of Commons. They are known today as *Hatsell's Precedents.*

Any group that conducts its meetings according to parliamentary rules will encounter questions about the proper procedure to be used. To answer such questions, the group should consult a standard book on parliamentary procedure. All such books tend to follow the same general basic purposes, but they may differ on specific points. Thus, an organization should follow one book for consistency.

Regardless of the book followed, an organization must establish an orderly procedure. Theoretically, an organization is free to construct its own set of rules of procedure as long as they do not violate the laws of the organization's country.

Above all, any system of parliamentary procedure should be both democratic and efficient. To ensure democracy, the rights of the minority must be protected and all members of the group must be able to discuss a matter before the majority disposes of that matter. To ensure that a system is efficient, the procedure must assist the group to carry out its business with a minimum of confusion and delay. It must also ensure that all members are aware of the substance and implications of each matter considered.

### Forming an organization

A group that wishes to form an organization first calls a meeting of those who may be interested. At this meeting, a temporary organization is established. The group selects an acting presiding officer, known as a *chairman, chairperson,* or *chair,* and an acting secretary, who begins keeping a record of the business transacted. The members then elect a temporary presiding officer and a temporary secretary, who serve until the organization is established permanently and permanent officers are elected.

**Constitutions.** Before a group officially becomes a permanent organization, it must prepare a *constitution* or a set of *bylaws* (rules). Some groups prepare both. However, because the two documents tend to duplicate

**The European Parliament** meets in Strasbourg, in eastern France. Its members are elected from each member country of the European Union.

material, many organizations today approve a single document usually known as the constitution. The constitution can be prepared by a committee elected by the organization or appointed by the temporary presiding officer. The constitution may be adopted as suggested by the committee, or it may be changed through the process of discussion and voting.

The constitution should define the basic characteristics of the organization and describe how the organization will operate. It should also include those rules that the organization considers sufficiently important to require prior notice and a larger majority for changing. These rules cannot be suspended except as provided for in the constitution. More specifically, a constitution usually covers the following subjects:

**I. Name of the organization**

**II. Object or purpose of the organization**
- A. A general statement of purpose
- B. How the purpose is to be achieved

**III. Membership**
- A. Types of memberships available with rights and privileges accorded to each type
- B. Selection process for membership
- C. Membership subscriptions (optional)

**IV. Officers**
- A. List of officers and duties
- B. Length of term of each office
- C. Method of electing each officer

**V. Meetings**
- A. Provisions for regular meetings
- B. Procedures for calling a special meeting
- C. Special rules governing meetings

**VI. Committees**
- A. Names and duties of standing committees
- B. Procedures for selecting special committees
- C. Method of selecting members and chairpersons of committees

**VII. Quorum**
- A. Minimum number of members required for regular and special meetings
- B. Minimum number of members required for a board meeting

**VIII. Parliamentary authority**
- A. Provision for adopting
- B. Scope of application

**IX. Amendment of constitution**
- A. Method of amending constitution
- B. Provision for adoption

The adoption of the first constitution requires only a majority vote by the membership of the organization. Upon adoption, the constitution immediately goes into effect. As soon as convenient, all members should be provided with a copy, as well as copies of other pertinent documents. Each new member should also receive the constitution and similar documents.

**Officers.** The essential officers for any organized group are a president (or chairperson) and a secretary. If the members pay subscriptions or raise money for the organization in any way, a treasurer is also necessary. Some groups have an officer who serves as both secretary and treasurer.

***The president*** (1) presides over all meetings, (2) supervises the work of other officers and committees, (3) represents the organization, and (4) appoints committees if the constitution or bylaws give the officer this power.

***The secretary*** (1) notifies members of scheduled meetings, (2) keeps and reads the minutes, (3) files committee reports, and (4) handles correspondence.

***The treasurer*** (1) handles all the organization's finances, (2) keeps a record of income and expenses, (3) prepares financial reports, and (4) helps prepare the annual budget.

***Other officers.*** Many organizations, especially if they are large or carry on extensive activities, have additional officers. These usually include a *vice president,* who aids the president and takes the president's place when that officer is unable to perform the duties of the position. An organization may divide the secretary's job between a *recording secretary,* who keeps the minutes and other records, and a *corresponding secretary,* who handles all letter-writing. There may also be a *membership secretary* to keep a record of members. Some organizations elect a *historian, archivist,* or *librarian* to keep a record of activities and look after written documents. Others may have a *publications secretary* or *journal editor,* if they send out a newsletter or magazine.

**Electing officers.** Most organizations elect officers once a year. There are two methods of nominating officers. Under the first method, the group chooses a nominating committee to propose one or more candidates

## Terms used in parliamentary procedure

**Adjourn** means to end a meeting.
**Agenda** is a list of items to be considered at a meeting.
**Amendment** is a change proposed or made in a motion, a constitution, or in bylaws.
**Appeal** is a request for a majority vote to overrule a decision of the presiding officer.
**Chairperson pro tempore** is the temporary chairperson.
**Close debate** refers to ending discussion on a motion by passing another motion to vote immediately.
**Decorum in debate,** refers to the observance of normal rules of courtesy and proper procedure while discussing motions.
**Dilatory motion,** is a delaying or meaningless motion. The presiding officer must rule it out of order.
**Gavel** is a small wooden hammer. The presiding officer of an organization uses it to call meetings to order and to quiet disorder during the meeting.
**Majority** is more than half of those voting.
**Order of business** is the series of steps covered in a meeting, from the call to order through to adjournment.
**Pending question** is the motion under consideration.
**Plurality** or *relative majority* is the largest number of votes received by any candidate in an election involving three or more candidates.
**Point of order** is an objection raised by a member because of improper procedure or annoying remarks. It must be ruled upon immediately by the presiding officer.
**Previous question** is a motion to close debate on a pending motion and vote immediately.
**Question of privilege** is a request that is made by a member who asks the presiding officer to deal with an emergency, disorder in the assembly, or other matters of general or personal welfare.
**Quorum,** is the minimum number of members required to be present at a meeting to transact business. Usually it is a majority of the total membership.
**Ratify** refers to a motion to approve an action already taken, such as a ruling by the presiding officer.
**Unanimous consent** refers to a request by the presiding officer on matters where differences of opinion are not expected. If there is an objection, a vote must be taken.

for each office. After the committee makes its nominations, other candidates may be nominated *from the floor* (by the members attending the meeting). Under the second method, the presiding officer declares that "nominations are in order." He or she then accepts nominations from the floor for each office.

A vote for officers, like votes on other business matters, may be held (1) by a show of hands or (2) by secret ballot. There are fewer risks of embarrassing any of the candidates when the members vote by secret ballot. In addition, the candidates do not have to leave the room during the voting. If only two candidates are nominated for an office, one must receive a majority of the votes to win. Usually, if three or more are nominated, the one who receives a *plurality* (the most votes) wins. But the constitution may require that a candidate must receive a majority vote to be elected. In such cases, the winner would be chosen in a further election between the two candidates with the most votes.

**Committees** handle many duties that a organization's officers do not or cannot perform. They also do jobs that cannot be done by the entire membership at regular meetings. Most organizations have two types of committees: (1) standing committees and (2) special committees.

***Standing committees*** deal with regular and continuing matters, such as membership and finance. These committees are usually selected after each annual election of officers, and they *stand* (remain active) throughout the year.

***Special committees*** may be selected at any time to deal with specific matters. A special committee might be appointed to plan a social event, to revise the group's constitution, or to nominate new officers. The special committee ceases to exist after it completes its assigned task.

The constitution usually states whether standing committees shall be appointed or elected. If they are to be appointed, the president names the members of each committee. The president usually creates special committees and appoints their members. Organization members can also create special committees by voting to do so. Each committee should have an odd number of members, in order to avoid tie votes on committee decisions. The president may select one of the committee members to be chairperson, or the committee may elect its own chairperson. Unlike the presiding officer, a committee chairperson does not have to be impartial. He or she participates in the discussion and voting. Committees do not have to follow the rules of parliamentary procedure. Thus, their meetings are usually informal discussions.

### Holding meetings

A business meeting officially begins when the presiding officer calls the group to order. He or she does this when a quorum is present. A *quorum* is the minimum number of members who must be present in order for the organization to transact business. In most organizations, a majority of the membership must be present in order to have a quorum. But a group's constitution can name any part of the total membership as a quorum. See Quorum.

**Order of business.** If the organization's constitution does not prescribe an order of business, there is a series of steps that are commonly accepted as a valid order: (1) call to order at the appointed meeting time with a quorum present; (2) read and dispose (corrections, additions, approval) of the minutes of the previous meeting; (3) reports of officers; (4) reports of boards; (5) reports of standing committees; (6) reports of special committees; (7) members consider unfinished business from previous meetings; (8) members consider new business; (9) announcements and requests that require no formal action; and (10) adjournment.

Sometimes the members want to devote an entire meeting to some special matter. The meeting would then follow a *special order of business.* After the minutes have been read by the secretary and approved by the members, the other items in the usual order of business would be dropped, and the special matter would be taken up.

**Minutes.** The secretary's minutes should be an accurate record of all the organization's actions. At the start of each meeting, the secretary reads the minutes of the previous meeting so the members can recall the actions taken. The secretary keeps a running account of all business matters the organization discusses and all actions it takes. The minutes do not summarize the discussions that take place during the meeting. They simply state the actions proposed, and what the organization decided to do about each one.

In most organizations, the secretary keeps the minutes in a permanent record book. Each set of minutes begins with the date and place of the meeting, the time the meeting began, and the name of the presiding officer. Some organizations call the roll at the beginning of each meeting, and include a list of the members present in the minutes. The secretary arranges the minutes in the order in which the members take up each item of business.

After the secretary has read the minutes, the presiding officer asks whether any member wants to make any corrections or additions. If so, the group must vote on each correction or addition. The presiding officer then asks for approval of the minutes. In some organizations, a member must propose that the group approve the minutes. But the simplest way is for the presiding officer to state that if there are no objections, the minutes will be considered approved. The secretary notes the approval and the date at the end of the minutes.

**Motions.** A *motion* is a brief, precise statement of a proposed action. A member can make a motion only when that member has been *recognized* by the presiding officer and *has the floor*—that is, has been given permission to speak. Some motions require a *second* before they can be discussed by the group. The act of seconding does not commit that member to supporting the motion. It signifies that member's interest in having the motion considered. After a motion has been made and seconded, the presiding officer restates the motion for the benefit of the rest of the members. In the case of a complicated motion, the secretary may be asked to read the motion from the minutes. The members then debate the motion. Perhaps the members want to *amend* (change) the motion in some way. If so, they must propose and *pass* (approve) a new motion amending the original motion. They must then debate the original motion *as amended.*

## Motions used in parliamentary procedure

The following motions are listed in order of their rank or precedence. When considering a main motion, subsidiary motion, or privileged motion, no motion listed below it may be introduced. However, any motion listed above it can be introduced. Incidental motions have no rank or precedence, usually grow out of the business being considered, and must be decided or disposed of before returning to the business under consideration.

| To do this | You say this | May you interrupt speaker? | Second needed? | Motion debatable? | Motion amendable? | Vote needed |
|---|---|---|---|---|---|---|
| **Privileged motions** deal with the welfare of the organization, rather than with any specific proposal. They must be disposed of before the group can consider any other type of motion. | | | | | | |
| **Adjourn the meeting** | "I move that we adjourn." | no | yes | no | no | majority |
| **Temporarily adjourn the meeting** | "I move we adjourn until___" | no | yes | no | yes | majority |
| **Raise a question concerning privileges, rights, comfort, or convenience of group or individual member** | "Question of privilege" | yes | no | no | no | none, presiding officer rules |
| **Subsidiary motions** provide various ways of modifying or disposing of main motions. | | | | | | |
| **Postpone temporarily consideration of a matter without voting on the matter; requires motion to resume consideration** (see **Main motions** below) | "I move we table the matter." | no | yes | no | no | majority |
| **End debate** | "I move the previous question." | no | yes | no | no | ⅔ majority |
| **Limit length of debate** | "I move debate on this matter be limited to___" | no | yes | no | yes | ⅔ majority |
| **Postpone consideration of a matter to a specific time** | "I move we postpone this matter until___" | no | yes | yes | yes | majority |
| **Have a matter studied further** | "I move we refer this matter to a committee." | no | yes | yes | yes | majority |
| **Amend a motion** | "I move that this motion be amended by___" | no | yes | yes | yes | majority |
| **Reject a main motion without voting on the motion itself** | "I move the question be postponed indefinitely." | no | yes | yes | no | majority |
| **Main motions** are the tools used to introduce new business. | | | | | | |
| **Introduce business** | "I move that___" | no | yes | yes | yes | majority |
| **Resume consideration of a motion previously tabled** | "I move we take from the table___" | no | yes | no | no | majority |
| **Reconsider a matter already disposed of** | "I move we reconsider our action relative to___" | yes | yes | yes | no | majority |
| **Strike out a motion previously passed** | "I move we rescind the motion calling for___" | no | yes | yes | yes | majority |
| **Incidental motions** arise out of the business being conducted. They have no order of precedence but should be disposed of as soon as they arise. The most frequently used incidental motions are listed below. | | | | | | |
| **Raise a question about an apparent violation of parliamentary procedure** | "Point of order" | yes | no | no | no | none, presiding officer rules |
| **Object to a ruling by the presiding officer** | "I appeal against the decision of the chair." | yes | yes | yes | no | majority |
| **Consider a matter that violates the normal rules of procedure but does not violate the organization's constitution or the laws of the country** | "I move to suspend the rules that interfere with___" | no | yes | no | no | ⅔ majority |
| **Object to considering a matter** | "I object to consideration of the matter." | yes | no | no | no | ⅔ majority |
| **Verify an indecisive show of hands vote by asking for a recount or a written vote** | "Recount!" or "I call for a written vote." | yes | no | no | no | none |
| **Withdraw a motion** | "I ask permission to withdraw the motion." | yes | no | no | no | none, if no objection; otherwise majority |
| **Seek information on rules of the organization or about the matter at hand** | "Point of information" | yes | no | no | no | none |

Debate on a motion usually continues until each member who wants to speak has done so. But the members can *close* (end) the debate at any time by passing a specific motion to have the group vote immediately. To do so, a member would *move the previous question.* The members can also pass a motion to set a time limit on the debate.

Each motion must be disposed of in some way before the group can take up another item of business. If the members want to postpone action on a motion, they may vote to "table the motion" or "lay the motion on the table." The presiding officer or the group may dispose of a motion temporarily by referring it to a committee. The committee investigates the matter and presents a report at a later meeting. The group then decides what action it wants to take. Eventually, all motions must be either approved or disapproved by a majority of the membership.

Every motion can be classified as one of four types: (1) privileged, (2) subsidiary, (3) main, and (4) incidental. These motions are explained in the table with this article.

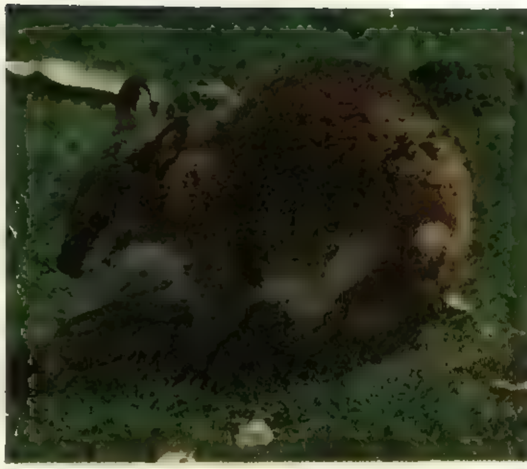
**Voting on motions** takes place when there are no more requests to speak on a motion, or after debate has ended. First, the presiding officer restates the motion or has the secretary read it. Then the presiding officer calls for a *voice vote.* All assembled members in favour of the motion say "aye." Then all those opposed say "nay." If the presiding officer cannot tell which side has the majority, he or she can ask supporters or opponents of a motion to stand or to hold up a hand. If a member doubts the accuracy of the presiding officer's announcement of a vote, that member should request a *division of the assembly.* This request requires a rising vote or a counted vote if necessary in order to determine the outcome accurately.

The constitution may require a *roll-call vote* on certain types of motions. A *secret ballot* is usually taken when electing officers and as required by the constitution. A *majority vote* is more than half of the legal votes cast unless otherwise defined in the constitution.

The presiding officer has the right to vote on all issues, but usually only votes when that vote would change the result of the vote by the members. The presiding officer may vote to break a tie vote. If the nay votes total one less than the aye votes, the presiding officer may cast a nay vote in order to create a tie vote and thus defeat the motion.

Parliamentary procedure does not have to be complicated and mysterious. As long as the presiding officer conducts meetings fairly and judiciously, and members learn the basic principles and procedures of parliamentary procedure, business can be transacted democratically and efficiently.

**Parma** (pop. 176,750) is a city in northern Italy. It lies about 120 kilometres southeast of Milan (see **Italy** [political map]). Parma dates from the period of the Roman Republic (509 B.C. to 27 B.C.). It has many art treasures. Its cathedral dates from the 1000's. It is an example of Lombard-Romanesque architecture. Its dome has a fresco, *Assumption of the Virgin,* by the artist Correggio (see **Correggio**). The University of Parma was founded in 1502. The area around Parma is famous for Parmesan cheese.



**The parma wallaby** is a member of the kangaroo and wallaby family. The native habitat of parma wallabies is the forests of the Great Dividing Range of coastal New South Wales, Australia.

**Parma wallaby** is a small, rare relative of the kangaroo. It is about 45 centimetres long with a tail of about the same length. It has a brown back, and white throat and chest. There is a dark stripe along the spine and a white stripe on the upper cheek.

From the 1930's to the 1960's, the parma wallaby was thought to be extinct. A colony was found in 1965 on a small island off the New Zealand coast, where a colony had been introduced about a hundred years previously. Another colony of parma wallabies was soon discovered in the native habitat, the eucalyptus forests of northeastern New South Wales.

Parma wallabies are nocturnal and are generally solitary. They hop about with their forearms tucked tightly into the chest. When they move about the body is held almost horizontally to the ground.

**Scientific classification.** The parma wallaby belongs to the kangaroo family Macropodidae. It is *Macropus parma.*

**Parmenides** was a Greek philosopher who lived about 500 B.C. He played an important part in developing pre-Socratic philosophy. Before Parmenides, philosophers generally explained the origin and nature of the universe in terms of one material substance, such as air. Parmenides used logical arguments to support his belief that what exists is one, eternal, indivisible, motionless, finite, and spherical. Therefore, it cannot become something else and other things cannot be explained by reference to its changing states. Change and *plurality* (reality consisting of many substances) are illusions.

Parmenides was born in Elea, a Greek colony in southern Italy. He was one of the first Greek philosophers to express his thought in poetry. His poem, *On Nature,* is divided into two parts. What is probably most of the first part has survived.

See also **Pre-Socratic philosophy.**

**Parnaíba River** rises in the Tabatinga Mountains near the border of the state of Goiás, Brazil. It flows 1,370 kilometres northeast to the Atlantic Ocean (see **Brazil** [map]). The river forms the border between the states of Maranhão and Piauí. Its chief tributaries include the Balsas, Gurgueia, Caninde, Poti, and Longa rivers. Ships

carry carnauba wax, cotton, rice, and tobacco about 480 kilometres from Floriano to the city of Parnaíba on the Atlantic coast.

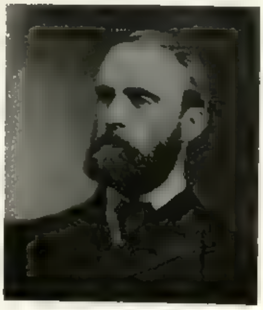
**Parnassus** is a mountain in Phocis in Greece. Its twin peaks rise to more than 2,400 metres. In ancient times, Parnassus was considered one of the most sacred Greek mountains. It was described as a favourite place of the gods Apollo, Pan, and Dionysus and the goddesses called the Muses. The famous oracle of Delphi was located on its lower slope. Nearby was the Castalian spring. It was supposed to inspire those who drank from it to write poetry.

See also **Delphi**.

**Parnell, Charles Stewart** (1846-1891), an Irish Nationalist leader, almost obtained *home rule* (self-government) for Ireland by constitutional means (see **Home rule**). But scandal ruined his career.

Parnell entered the British House of Commons in 1875 as a member for County Meath. He united the Home Rule party, and tried to make it powerful by obstructing all other legislation until Irish demands were met. To unite Ireland, Parnell came to terms with Irish revolutionaries, and supported the Land League. The league wanted land reforms that would end with tenant farmers owning their farms.

In 1879, Parnell visited the United States and collected large amounts of money for the Land League. When he returned to Ireland, he suggested *boycotting* the landlords in order to force land reform (see **Boycott**). For this policy and for trying to obstruct legislative proceedings, Parnell was arrested and imprisoned for six months. From prison, he urged tenant farmers not to pay rent. This advice added bitterness to the situation. After his release in 1882, Parnell returned to Parliament and tried again to force home rule. For a time he seemed about to succeed. In 1886, Parliament passed the Tenant's Relief Bill, which improved farmers' conditions.



**Charles Parnell**

But the next year, Parnell had to defend himself against charges that he was involved in the Phoenix Park murders. Irish terrorists had committed these murders in 1882. Parnell proved that letters which seemed to implicate him were forgeries.

In 1889, just as Parliament was about to meet, a political supporter of Parnell named Captain William O'Shea filed divorce proceedings against his wife because of her relationship with Parnell. The charges were proved, and Parnell's reputation and influence were ruined. Parnell married Mrs. O'Shea after the divorce.

Parnell was born on his family's estate of Avondale in County Wicklow, Ireland. He was educated at Magdalene College, Cambridge University.

**Parody** is a comic imitation of a literary work. A writer creates a parody to ridicule the work of another by exaggerating that author's style or treatment of subject matter.

Parodists usually choose famous writers who have a distinctive style, so that the reader can easily recognize the subject of the parody. An expert in the field was the English writer Sir Max Beerbohm (1872-1956), whose *Christmas Garland* (1912) parodies the novelist Henry James, among others.

A successful parody demonstrates not only the understanding of the original author, but also the parodist's own skill. Although parody involves criticism, it is also a kind of appreciation. By selecting a certain author, the parodist acknowledges that the subject is both original and well known.

Many early English novelists began their careers as parodists, including Jane Austen, Henry Fielding, and William Makepeace Thackeray. A leading American parodist of the mid-1900's is Peter De Vries. Almost all his novels have passages in which he parodies the work of others. Outstanding collections of parodies include *Parodies: An Anthology from Chaucer to Beerbohm and After* (1960), edited by Dwight MacDonald.

**Parole** is the early release of criminals from prison, in most cases as a reward for good behaviour. A prisoner can be paroled only after serving part of his or her sentence. Parole is a continuation of a sentence away from prison, and paroled prisoners, called *parolees,* must follow certain rules. For example, they must get a job, support their family, and avoid alcohol and other drugs. If the parolees violate any of the rules, or if they commit another crime, they may be sent back to prison.

A parole board decides whether a criminal should be released on parole. Each country has its own rules about how much of a sentence must be served before a prisoner can be considered for parole. A board considers such factors as the crime involved, the time already served, and the criminal's behaviour in prison. Parolees are supervised by a parole officer for a certain period, depending on the sentence and the time served.

Parole has several purposes. Some law enforcement officials believe parolees have a better chance of becoming law-abiding citizens than criminals released without supervision. Parole also tries to protect society by preventing offenders from committing new crimes. In addition, parole costs society less than keeping people in jail.

Since 1970's, some criminologists have started criticizing parole. They believe parole does not help prisoners readjust to society. They also think the main purpose of prison should be to punish criminals, not to reform them. These critics charge that the parole system is unfair because criminals who commit the same crime may not have to spend the same length of time in prison. Some may be paroled sooner than others. They advocate a system of *fixed sentences.* Under this system, criminals must serve a specific amount of time in prison, depending on their crime.

Parole differs from probation. A judge may place a criminal on probation instead of sending him or her to prison. Criminals are paroled only after they have served time in prison. See **Probation**.

**Paroquet.** See **Parakeet**.

**Parotid gland.** See **Saliva**.

**Parotitis.** See **Mumps**.

**Parr, Catherine.** See **Henry (VIII, of England)**.

**Parrakeet.** See **Parakeet**.

**St. John's Cathedral** in Parramatta, Australia was begun in 1799. Additions were made later.

**Parramatta** (pop. 130,783) is one of Sydney's largest local government areas and the geographic and population centre of the Sydney metropolitan area. It is located 24 kilometres west of Sydney's central business district.

Parramatta is the second oldest settlement in Australia. It was founded on Nov. 2, 1788, by Governor Phillip, who travelled with a small party from Sydney by boat to select a site for a *redoubt* (a small fort). The initial name given by Governor Phillip for this area was *Rose Hill.* On June 4, 1791, the governor renamed it *Par-ra-mat-ta,* the name by which the Aborigines knew the locality. It is said to mean *place where the eels lie down.* Later explanations of the name suggest that the real meaning is probably *head of the river.*

Parramatta was originally settled to help produce grain to feed the near starving colony. James Ruse, a former convict and experienced farmer who was given the first land grant, established wheat and maize crops. A number of Parramatta settlers were pioneers in the sheep industry. John and Elizabeth Macarthur began the export of wool to England. Their home, Elizabeth Farm, is the oldest surviving house in Australia.

See also **Elizabeth Farm House; Ruse, James.**

**Parrish, Maxfield** (1870-1966), an American painter and illustrator, portrayed a world of rich colour and poetic fancy. His travels in Italy and his later life among the New Hampshire mountains developed his love for romantic, idealized natural beauty. The towering peak of Ascutney, within sight of his home, is suggested in many of his works. An unusual shade of blue, which Parrish used in many of his pictures, came to be known as "Maxfield Parrish blue."

Posters, magazine covers, murals, and other decorations demonstrate his skilful draughtsmanship and distinctively elegant style. The many books he illustrated include *Mother Goose in Prose, Knickerbocker's History of New York, The Arabian Nights, Wonder Book, Poems of Childhood, Golden Age,* and *Dream Days.* The rich and glowing colours that Parrish used attracted many admirers.

Parrish was born in Philadelphia, Pennsylvania, U.S.A. of Quaker parents. He graduated from Haverford College, Pennsylvania, and later studied at the Pennsylvania Academy of the Fine Arts. He also studied under Howard Pyle at Drexel Institute of Art, Science and Industry, Philadelphia.

**Maxfield Parrish** painted in a distinctive, elegant style. His painting, *left,* demonstrates his love for romantic, idealized natural beauty and his use of rich, glowing colours.

**Parrot** is one of a large family of colourful birds. Most *species* (kinds) of parrots are found in warm, tropical regions. A parrot is a popular pet because it is easy to tame and can be taught to talk. Every parrot has a short, thick, hooked *bill* (beak) and feet with two toes pointing forward and two backward. The smallest parrot is about 10 centimetres long and the largest measures 100 centimetres. The tail is short and square-ended in some parrots, and in others may be long and pointed. Most parrots very colourful, with red, green, yellow, or blue feathers.

Parrots are sociable and noisy birds. Most parrots live in tropical rainforest, but some live in lowland plains or in mountain forests.

**Kinds of parrots.** There are about 340 species of parrots found around the world, mainly in the Southern Hemisphere.

Nearly half the world's parrots are found in Central America, South America, and the Caribbean islands. These include the *macaws,* the largest parrots. Most macaws are blue or green, with a long tail and a very large bill. The best known is the *scarlet macaw,* which is mainly red with a blue back, and blue and yellow wings. Its tail makes up more than half of its 85-centimetre total length. The *amazon parrots* are mainly green and about 25 to 40 centimetres long, with a short rounded tail. Many amazon parrots are found on Caribbean islands, some being found on only one island. The rarest is the *Puerto Rican amazon,* found only on the island of Puerto Rico, where much of its rainforest habitat has disappeared. Other American parrots include the *conures* and a number of small *parrotlets* and *parakeets.* The only species native to North America, the *Carolina parakeet,* became extinct in the early 1900's.

Most of the rest of the world's parrots are found in Indonesia, the Philippines, Australia, New Zealand, or small Pacific islands. The most familiar of these is the *budgerigar,* which lives in Australia. In their wild state, budgerigars are green. The tremendous colour variations found in captive birds are a result of selective breeding. Another well-known Australian parrot is the *cockatiel,* a medium-sized, grey parrot with a long tail and a distinctive *crest* (tuft of long feathers on the head). The *ground parrot* and the *night parrot* are ground-living birds that are unique to Australia. The ground parrot builds a large nest made up of grasses, in a scrape on the ground. The night parrot is strictly nocturnal. It lives mainly in areas of porcupine and spinifex bushes, in which it builds its nest.

The *kea* from New Zealand is a large, dark green parrot which lives in mountainous forests and scrub. It feeds on berries, fruit, and seeds, but will also eat *carrion* (the flesh of dead animals) and has been accused of attacking and killing sheep. The world's smallest parrots, *pygmy parrots,* are also found in New Guinea. They are about 10 centimetres long, green, and have short, stiff tail feathers which help them to climb tree trunks. *Cockatoos* are found mainly in Australia and New Guinea. They are about 35 to 75 centimetres long and range in colour from white, in the case of the *white cockatoo,* to black, in the case of the *palm cockatoo.* Many cockatoos have large crests.

*Lories* and *lorikeets* are found in New Guinea and on many Pacific islands. They are mainly bright red or green in colour, some with long tails. The most unusual of all parrots, the *kakapo,* is found in New Zealand. It is about 60 centimetres long, greenish-brown and yellow, and has a fairly short tail. It cannot fly and is active at night, living in mossy forests, where it climbs trees and rocks with ease but runs clumsily over the ground. Forest clearance and rats have brought this remarkable bird to the edge of extinction and only about 50 survive.

The remaining parrots are found in Africa and Asia. The *grey parrot* of Africa is common as a pet. It is about 33 centimetres long, with a thick-set body. It has grey plumage, with a short, square red tail. *Ring-necked parakeets* are the most widespread parrots, found from Africa to India. They are also common as cage-birds and breeding populations of escaped birds have become established in Europe. Ring-necked parakeets are green, with long bluish tails and a red neck-collar. The closely related *Derbyan parakeet* lives at the greatest altitude—up to 4,000 metres in the Tibetan Himalaya. *Lovebirds* are small (10 to 15 centimetres long), green African parrots with short, rounded tails. They are popular as pets.

Parrots mate for life and a pair will constantly preen one another to maintain the bond between them.

Most parrots feed on seeds, nuts, berries, and fruit, which they collect from trees or off the ground.

**Parrots as pets** are a common sight in many countries. Their ability to copy human speech makes them endearing pets. In the wild, parrots have loud screeching calls or high whistles and chatters. They are not known to copy other sounds. In captivity, however, they may learn a large number of words. One African grey parrot developed a vocabulary of nearly 800 words. Many parrots live to a great age. One of the longest lived was London Zoo's *sulphur-crested cockatoo* called 'Cocky', which was at least 80 years old when he died.

**Kakapo**
*Strigops habroptilus*
Found in New Zealand
About 65 centimetres long

**Rainbow lorikeet**
*Trichoglossus haematodus*
Found from East Indies
and Australia to Vanuatu
30 centimetres

**Scarlet macaw**
*Ara macao*
Found from Mexico to Bolivia
85 centimetres

**Yellow-headed Amazon**
*Amazona ochrocephala*
Found from Mexico
to Ecuador and Brazil
35 centimetres

**Sulphur-crested cockatoo**
*Cacatua galerita*
Found in Australia and New Guinea
50 centimetres

Parrots can carry a disease, *psittacosis* or *parrot fever.* This illness also affects many other kinds of birds and can be transmitted to human beings. See **Psittacosis.**

The popularity of parrots as cage birds has led to a huge trade in wild birds. Many species have been brought close to extinction as a result of illegal trapping. Despite laws that protect and forbid the exportation of rare parrots, thousands of such birds are caught each year. The world's rarest parrot is the *Spix's macaw,* of northeastern Brazil. There may be only one bird left in the wild—all others have been caught.

**Scientific classification:** Parrots belong to the order Psittaciformes. The lories and lorikeets are in the family Loriidae. Cockatoos are in the family Cacatuidae. The remaining parrots, including the budgerigar, conures, macaws, and parakeets, are in the family Psittacidae.

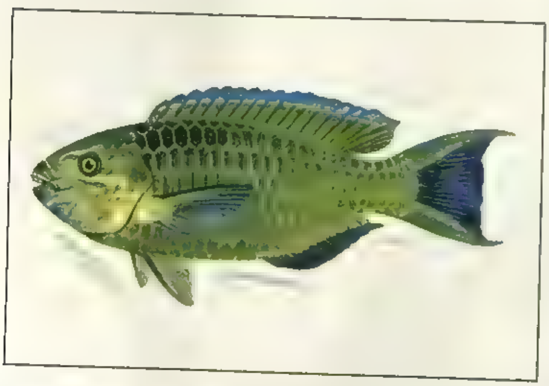
**Related articles** in *World Book* include:

| | | |
|---|---|---|
| Budgerigar | Kakapo | Macaw |
| Cockatiel | Kea | Parakeet |
| Cockatoo | Lovebird | Psittacosis |

**Parrot fever.** See **Psittacosis.**

**Parrotfish** is the name of a group of about 75 species of fish that live around coral reefs in tropical and subtropical seas. They get their name from their unusual front teeth, which resemble a parrot's beak.

Parrotfish range in size from 10 centimetres to more than 1.2 metres. They have thick bodies covered with large, thick scales. Most parrotfish are brightly coloured and most change colour during their lifetime. In some species, a fish born female will later become a male.



**The queen parrotfish lives in the western Atlantic.**

Parrotfish feed mostly on algae, which they scrape off rocks and corals with their strong teeth. Many parrotfish feed on sea grasses around coral reefs, often grazing in large schools. The *queen parrotfish,* which lives in tropical parts of the western Atlantic, sometimes grazes in groups of three or four females and one male. Parrotfish eat during the day and rest at night. Many species of parrotfish form a type of thin, transparent, cocoonlike covering around themselves at night and rest in it until daylight.

**Scientific classification.** Parrotfish are in the family Scaridae. The scientific name for the queen parrotfish is *Scarus vetula.*

**Parry, Sir Hubert** (1848-1918), a British composer, is best remembered for his choral music. His song "Jerusalem," a setting of a poem by William Blake, and his choral work *Ode at a Solemn Music, "Blessed Pair of Sirens,"* are his most frequently performed works. He also composed an opera, an oratorio, much church music and chamber music, several orchestral works, and many songs. Charles Hubert Hastings Parry was born at Bournemouth, in Dorset, England. In 1894, he became director of the Royal College of Music, in London.

**Parry, Sir William** (1790-1855), a British naval officer and Arctic explorer, led official expeditions in 1819, 1821, and 1824, in search of the Northwest Passage. Parry discovered Melville Island on one of these voyages (see **Melville Island**).

In 1827, Parry sailed in his ship *Hecla* in an attempt to reach the North Pole by way of Spitsbergen. At Trurenberg Bay, he and his party left the ship and started north. The 28 members of the expedition took two boats and enough supplies for about 70 days. Steel runners attached to the boats enabled them to travel on the ice as well as to sail on the water. The expedition reached 82°45′ north latitude. It came within 800 kilometres of the North Pole, the farthest north any explorer had gone until then and remained a record until 1876.

Detail of an oil painting on canvas (1820) by Samuel Drummond, P.E. Parry, Furneu Pelham, Hertfordshire, England.

**Sir William Parry**

Parry described his travels in *Voyage for the Discovery of a Northwest Passage* (1821) and *Narrative of an Attempt to Reach the North Pole in Boats* (1828). William Edward Parry was born in Bath, England.

**Parsec** is a traditional unit used in astronomy to measure the distance between stars. A parsec has a length of 3.26 light-years, 30,900,000,000,000 kilometres. The word *parsec* is a combination of the words *parallax* and *second.* A parsec is equal to a distance where the radius of the earth's orbit would produce a parallax of one second of arc. See also **Parallax.**

**Parsees,** also spelled *Parsis,* are members of the Zoroastrian community located mainly in the area of Bombay, India. Parsees are descended from Persian immigrants of the A.D. 600's to 900's who fled from Persia (now Iran) to escape persecution by the Muslims.

Parsees believe in the god Ahura Mazda and worship in fire temples. A sacred fire burns continuously in the temples to symbolize Ahura Mazda. The temples are closed to nonbelievers. No special day is set aside for worship, but religious activity becomes festive at the New Year and on the birthday of the prophet Zoroaster. Parsees follow the sacred book called the Avesta, which teaches good thoughts, good words, and good deeds.

In spite of their small numbers, Parsee Zoroastrians have gained a reputation for their leadership in education and have earned distinction in commerce, industry, the arts, and politics. Charity plays an important role in the community.

See also **Zoroastrianism; Funeral customs** (The funeral).

**Parsing** is a form of recitation involving the analysis of each word in a sentence. The term *parsing* comes from the Latin *pars*, meaning *part*.

In parsing a sentence like *The boy found a penny*, a student might say: (1) *Boy* is a common noun, third person, singular number, masculine gender, nominative case, and subject of the verb *found*. (2) *Found* is a transitive, finite, predicating verb, third person, singular number, active voice, indicative mood, and past tense. (3) *Penny* is a common noun, third person, singular number, neuter gender, objective case, and object of the verb *found*.

Much of this recitation is unnecessary, and even misleading. For example, it may be meaningful to say that *boy* is a common noun, but not that it is third person, because all nouns are third person. English nouns do not distinguish between subject and object forms. The case of *boy* would be described as *common* (see **Case**).

Most schools have abandoned parsing as a method of teaching and have replaced it with sentence diagramming (see **Sentence** [Diagramming]).

See also **Parts of speech**.

**Parsley** is a biennial vegetable, usually considered as a herb. It is closely related to caraway. The most popular variety produces a low-growing rosette of finely curled and crumpled green leaves. Another variety of parsley produces plain leaves. The fresh leaves are used mainly to decorate meat dishes and salads. The leaves of parsley can also be dried and used in soups.

A variety of parsley called Hamburg parsley produces a long root that may be stored for winter use. Hamburg parsley is used mainly as a soup flavouring.

Parsley is an excellent source of all vitamins. It is especially rich in vitamins A and C and in the minerals iron and calcium. But it is usually eaten in such small quantities that it has little effect on a person's health.

In areas with a mild climate, parsley can be sown out of doors. A fertile, well-drained soil in a sunny position is suitable. The seeds should be sown in *drills* (small burrows). In areas with severe winters, parsley can be sown first in a greenhouse or hotbed and then transferred outside after danger of frost has passed. Sometimes parsley plants are potted and grown indoors in a sunny window during winter.

Parsley was first grown in Sardinia and southern Italy. Early Romans used parsley to fashion garlands to crown military and athletic heroes.

**Scientific classification.** Parsley belongs to the parsley family, Umbelliferae (Apiaceae). It is *Petroselinum crispum*.

**Parsnip** is a biennial vegetable with many deeply and finely lobed leaves. The edible part of the parsnip is its long tapering white root. Parsnips are a common plant in home gardens, but the vegetable has little commercial importance. Parsnips are related to carrots and dill.

The parsnip grows best in a deep rich soil. The seeds must be sown in early spring. The plants come up slowly and unevenly. Parsnip roots grow slowly until cool autumn weather sets in, then they grow rapidly. Parsnip roots are not injured by freezing, and are often left in the ground over winter which is also thought to improve their flavour.

Parsnips are usually free from insect enemies and suffer from few diseases. The parsnip provides moderate amounts of vitamins and minerals. Its calorie level is similar to that of the potato. It is a tasty vegetable, especially when *braised* (lightly browned in fat, then cooked in a little vegetable or meat stock in a closed container).

The parsnip is native to the Rhine Valley in Europe. It was known and probably used as food early in the Christian Era. It was cultivated in England in 1592 and indroduced into the Americas in the early 1600's.

**Scientific classification.** The parsnip belongs to the parsley family, Umbelliferae (Apiaceae). It is classified as *Pastinaca sativa*.

**Parsons, Sir Charles** (1854-1931), a British engineer, invented the steam-turbine engine, and built the first turbine-powered steamship, *Turbinia*, in 1897. His other inventions included a helicopter, a model monoplane, and nonskid motorcar chains. Charles Algernon Parsons was born in London. See **Ship** (Increasing power and speed); **Turbine** (History).

**Parsley** is a garden vegetable. The most popular variety produces clusters of finely curled and crumpled green leaves.

**The parsnip** is a garden vegetable. The edible part of the plant is its long tapering white root, which resembles a carrot.

**Parsons, Robert** (1546-1610), led a Jesuit mission to England in 1580 with Edmund Campion (see **Campion, Edmund**). Parsons achieved some success but soon had to flee England. He later devised a plan to invade England that led to the sailing of the Spanish Armada in 1588. Parsons was born in Nether Stowey, Somerset, England. He first left England in 1574 and became a Roman Catholic.

**Parthenogenesis.** See **Reproduction** (Sexual reproduction in animals).

**Parthenon** is an ancient Greek temple in the city of Athens. The temple stands on a hill called the Acropolis overlooking the city. The Parthenon was dedicated to Athena, the city's patron goddess. The temple is probably the best example of ancient Greek architecture.

The Greeks erected the Parthenon between 447 and 432 B.C. The temple was designed by the Greek architects Ictinus and Callicrates. The Greek sculptor Phidias designed the sculptural decoration for the building. The Parthenon became a Christian church about A.D. 500. After Turkish Muslim forces captured the city, in the mid-1400's, the Parthenon served as a mosque. In 1687, the Parthenon was badly damaged when the Venetians tried to conquer Athens. At the time, the Turks were using the Parthenon for storing gunpowder, which exploded and wrecked the central part of the building. Most of the remaining sculpture was moved to the Acropolis Museum in Athens and the British Museum in London (see **Elgin Marbles**). Only ruins of the building remain.

The Parthenon was built entirely of *Pentelic marble,* a white marble that was brought from Mount Pentelicus 18 kilometres from Athens. The temple is a rectangular building that measures 72 metres long and 34 metres wide. It stands about 18 metres high.

The Parthenon contains a central enclosed space, called a *cella,* which is divided into two rooms. One of the rooms once contained a huge gold and ivory statue of Athena, and the other room once served as a treasury. A row of 46 Doric columns surrounds the cella on all four sides.

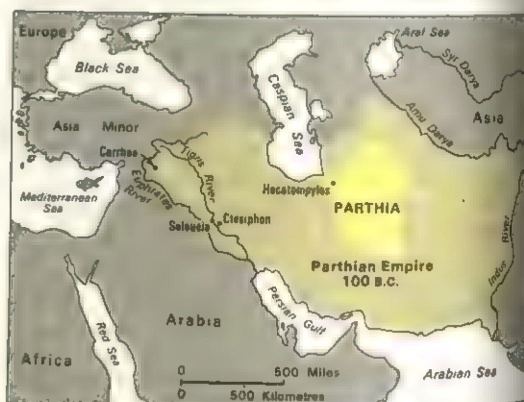
Brightly painted sculpture originally decorated the Parthenon. Sculptures once filled the two *pediments* (triangular ends of the roof). The eastern pediment was decorated with scenes showing the birth of Athena. The temple's western pediment showed the legendary battle between Athena and the sea god Poseidon for the control of Athens.

Around the top of the outer wall above the columns of the Parthenon was a series of small sculptured panels called *metopes.* The metopes showed famous mythological battles between the Lapiths and the centaurs, the gods and a race of giants, and Greeks and Amazons. These sculptured panels also presented battle scenes from the Trojan War. Along the outer wall of the cella was a continuous horizontal *frieze* (decorated band). The frieze showed the people of Athens, including Athenian officials, priests, maidens, and young men on horseback, in the annual procession honouring the birthday of Athena.

See also **Greece, Ancient** (picture: The Parthenon in Athens); **Phidias.**

**Parthia** was an ancient kingdom southeast of the Caspian Sea, in Asia. Parthians lived a simple life and were noted as warriors. Hecatompylos was the capital of Parthia.

The Parthians were independent until the 500's B.C., when Cyrus the Great of Persia conquered them. Alexander the Great of Macedonia also conquered Parthia, and it later became part of the Seleucid kingdom. By 235 B.C., Parthia had regained its independence, and it soon ruled a large empire in the East.




**Parthia** was an ancient kingdom in Asia. It began to expand about 235 B.C. and soon ruled a large empire in the East.

**The Parthenon** is an ancient Greek temple in Athens that was built to honour Athena, the patron goddess of the city. It was constructed entirely of white marble.

Parthia fought several wars against the Romans, defeating Crassus in 53 B.C. and Mark Antony in 36 B.C. and losing to Trajan in A.D. 116. A Persian revolt overthrew the Parthian rulers about 224, and Parthia later became a part of the Sassanid Empire that was founded by Ardashir I.

**Participle** is a verb form used as an adjective without losing its character as a verb. Like a verb, a participle may have an object or an adverbial modifier.

A word can often be identified as a participle only because it takes an object. In the sentence *The shouting mob, hurling stones, moved forward,* the word *shouting* is an adjective that modifies *mob.* The word *hurling* also modifies *mob,* but it is a participle because it has an object, *stones.*

A verb has two participles in the active voice. The present participle—for example, *drawing*—expresses action in progress. The past participle, *drawn,* expresses finished action. The perfect participle, *having drawn,* is a modified form. The participle forms in the passive voice are *being drawn* for the present tense, *drawn* for the past tense, and *having been drawn* for the perfect tense.

A present participle used as a noun is called a *gerund.* Gerunds, even though they function as nouns, keep the characteristics of a verb. In the sentence *Talking nonsense is sometimes fun,* the word *Talking* is the subject of *is,* but *nonsense* is the object of the gerund. In *By talking good sense, he won respect,* the word *talking* is the object of a preposition. See **Gerund.**

When using a participle as an adjective, many people make the error of creating a *misplaced modifier.* In *Walking up the hill, a church came into view,* the word *Walking* is misplaced because the sentence does not make clear who is walking. The sentence can be clarified in either of two ways: *Walking up the hill, we came within sight of a church* or *As we walked up the hill, a church came into view.*

The participle in an *absolute phrase* functions independently. An absolute phrase does not modify any particular word in the main clause, but it has its own subject. In *The leaves having fallen, we raked them,* the words *having fallen* are a present perfect participle. But this participle is not misplaced because it is part of the absolute phrase *The leaves having fallen.*

**Particle, Atomic.** See **Atom** (The parts of an atom); **Particle physics.**

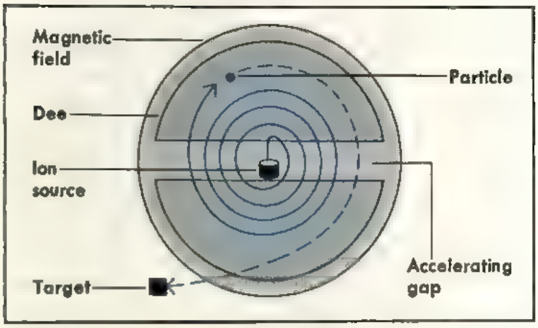
**Particle accelerator** is an electric device that speeds up the movement of atomic particles. It can accelerate such particles as electrons or protons and give them extremely high amounts of energy.

Accelerators serve as valuable tools for scientific research into the nucleus of an atom. They enable physicists to change the atom of one element into that of another element. This change, called *transmutation,* results from reactions that occur when accelerated particles collide with the nucleus of any atom. High-energy accelerators also help physicists discover new kinds of particles and study their relation to the forces that hold the nucleus together. These new particles are created by smashing the nucleus with electrons or protons boosted to tremendous speeds. Accelerators are sometimes called *atom smashers* because of such experiments.

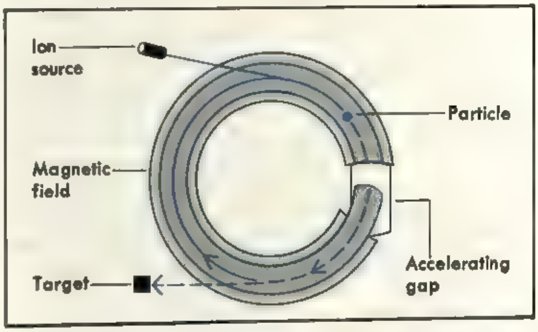
Accelerators also have other important uses. In industry, electron accelerators are used as powerful X-ray machines to detect hidden flaws in metal *castings* (moulded parts) and in the production of semiconductors. In medicine, accelerators serve as X-ray machines and are used to diagnose and treat cancer.

**How accelerators work.** Accelerators vary in design and size, but they all operate on the same general principles. They all use only electrically charged particles. Most accelerators use electrons, which are negatively charged, or protons, which are positively charged. These particles are produced by devices outside an ac-

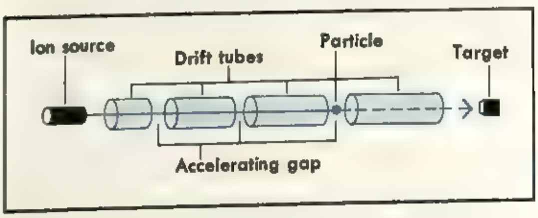
**How particle accelerators work**




**In a cyclotron,** a particle is drawn out from an ion source by one of the semicircular electrodes called *dees.* The magnetic field causes the particle to travel in a circular path. Each time the particle crosses an accelerating gap, it receives an energy boost and moves outward until it collides with the target.




**In a synchrotron,** a particle is bent by a magnetic field to move in a fixed circular orbit. As the particle gains energy, the magnetic field grows stronger to keep it moving on the same path. After crossing the accelerating gap a number of times, the particle reaches its peak energy and whirls out toward the target.




**In a linear accelerator,** a particle moves in a straight line through a series of drift tubes. As the particle passes through the accelerating gaps between the tubes, it gains speed and builds up energy. The drift tubes enable the particle to maintain its speed so it will strike the target with maximum force.

celerator and released into its vacuum chamber or tube.

Accelerators speed up particles by means of an *electric field,* a region of space in which an electric force acts on a charged body. Such a field is generally produced across a gap between a pair of electrodes to which an electric voltage has been applied. When particles pass through this *accelerating gap,* the electric field accelerates the particles by acting on their charges.

The amount of energy gained by a particle is proportional to the voltage generated to create the electric field. In high-energy accelerators, the particles undergo a series of small accelerations to build up energy. Some lower-energy accelerators use one steady electric field to accelerate the particles.

Physicists measure the energy of particles in units called *electronvolts* (eV). Accelerators can produce particles with energy in the range of thousands of electronvolts (keV), millions of electronvolts (MeV), billions of electronvolts (GeV), or trillions of electronvolts (TeV).

**Kinds of accelerators.** Accelerators can be classified by the kind of path followed by their accelerated particles. The two basic types are circular and linear.

***Circular accelerators*** use one or more large electromagnets to produce a strong magnetic field that makes particles travel in circular orbits. In these orbits, the particles pass through the same accelerating gap each trip around. The electric field across the gap alternates at high frequency so that it changes in *phase* (step) with the passage of the particles. In other words, the field accelerates the particles in the direction of their travel just as they cross the gap. This process is called *resonance acceleration.*

Circular accelerators include a wide variety of machines that have different features. In a *cyclotron,* for example, the magnetic field stays the same and the particles spiral outward as they gain energy. In a *synchrotron,* the magnetic field grows stronger each time the particles receive an energy boost. It thus keeps them moving in a circular orbit of constant radius. The *betatron,* like the synchrotron, has an increasingly stronger magnetic field. But this magnetic field does more than hold the particles to their circular path. As the magnetic field increases in strength, it also produces an electric field that accelerates the particles.

***Linear accelerators*** make atomic particles move in a straight line. In one kind of linear accelerator, the particles travel through a series of pipes called *drift tubes* that are separated by accelerating gaps. Rapidly alternating electric fields accelerate the particles as they pass across the gaps. The drift tubes enable the particles to coast from one gap to the next without losing speed.

Another kind of linear machine accelerates the particles through one long pipe by means of an electromagnetic wave that travels with the particles. The wave carries the particles to steadily higher energies as they travel from one end of the pipe to the other.

**History.** In 1932, physicists John Cockcroft of the United Kingdom and Ernest Walton of Ireland became the first to break down atomic nuclei with accelerated particles. Their accelerator boosted protons to 500 keV. Through the years, scientists in Europe and the United States have developed accelerators capable of higher and higher energies. In 1967, Soviet physicists built a 76-GeV proton synchrotron in Serpukhov. In 1972, United States physicists accelerated protons to an energy of 400 GeV. They used a giant synchrotron at the Fermi National Accelerator Laboratory in Batavia, Illinois. In 1986, a new synchrotron was used to accelerate protons to an energy of 900 GeV.

In 1987, the Super Proton Synchrotron built by the European Organization for Nuclear Research (CERN), near Geneva, Switzerland, accelerated oxygen nuclei to more than 3 TeV. The particles reached a velocity of 99.9999 per cent of the speed of light.

In 1993, the United States halted construction of the Super-conducting Super Collider (SSC), which would have been the world's largest accelerator. In 1994, particle physicists worldwide awaited confirmation that CERN's Large Hadron Collider (LHC) will be built. The proposed LHC, the next best instrument for particle research, is only a third as powerful as the cancelled SSC.

**Related articles** in ***World Book*** include:

Atom (How scientists study atoms; picture)
Betatron
CERN
Cockcroft, Sir John D.
Cyclotron
Linear accelerator
Los Alamos National Laboratory
Radiochemistry
Synchrotron
Van de Graaff generator
Walton, Ernest T. E.

**Particle physics** is a branch of physics that deals with the particles that make up atoms. These *subatomic particles* include the three basic parts of atoms: positively charged *protons,* negatively charged *electrons,* and electrically neutral *neutrons.* Protons and neutrons form the nucleus of an atom. Electrons whirl about the nucleus. There are also many unstable particles, which usually do not occur in atoms. Such particles exist very briefly before *decaying* (breaking down) into lighter particles. Particle physics branched off from nuclear physics after researchers discovered these unstable particles. Their discovery led to the conclusion that protons and neutrons consist of smaller particles.

**Families of particles.** Physicists have grouped subatomic particles into three major families: (1) leptons, (2) quarks, and (3) bosons. These three types of particles are *elementary particles*—that is, they do not seem to be made up of smaller units and their size has so far proved to be too small to measure. Elementary particles are more than 100 million times tinier than atoms.

***Leptons.*** Physicists have discovered six types of leptons. They are *electrons, muons, taus,* and three kinds of *neutrinos.* The neutrinos have no electric charge. The other leptons have a negative charge. See **Lepton.**

***Quarks,*** unlike leptons, never occur alone in nature. They always combine to form particles called *hadrons.* The only stable hadrons are protons and neutrons, which consist of combinations of quarks called *up* (or *u*) and *down* (or *d*). Each quark carries an electric charge one-third or two-thirds the charge of an electron. Physicists have also identified unstable quarks, including *strange, charmed,* and *bottom.* Quarks can combine and form over 300 types of hadrons. See **Quark; Hadron.**

***Bosons*** transmit forces between particles. The known bosons are *photons; gluons;* and *weakons,* or *weak bosons.* Photons, which are particles of light, carry the electric force that keeps electrons within atoms. Gluons hold the quarks in hadrons together. Weakons can change one type of quark or lepton into another. See **Boson; Photon; Gluon.**

**Research in particle physics** is conducted chiefly with *particle accelerators.* These devices speed up the movements of electrons, protons, and other particles to nearly the velocity of light. Some particle accelerators shoot a single beam of particles that collides with a stationary target outside the device. Others produce two beams of particles that shoot in opposite directions and collide with each other inside the device. By observing the particles that emerge from the collisions, physicists learn about the forces controlling the particles during the collisions.

Sometimes, the energy that is released in a collision creates new particles. Most of these particles decay in less than a billionth of a second. Physicists track the movements of such particles in various ways. In one method, they photograph trails left by particles as they pass through certain transparent materials. Another tracking method uses a device that produces an electric signal when a particle passes through it. The signals may then be transmitted to a computer, which reconstructs the paths of the particles that emerge from the collision.

Particle physicists seek to identify all the elementary particles and to construct a mathematical theory about their behaviour. They also want to discover the origin of the mass carried by many particles. Some scientists believe the mass results from the action of bosons called *Higgs bosons.* But the existence of these bosons has not yet been directly proved.

See also **Atom; CERN; Particle accelerator; Quantum mechanics.**

**Partisans** work behind enemy lines in wartime to weaken an opponent's hold on the partisans' homeland, and to support the military operations of allies. They perform reconnaissance and sabotage, and disturb enemy movements as much as possible. Partisans do not belong to the regular army but usually operate under a professional military commander or under the orders of a regular military force.

See also **Guerrilla warfare; Underground.**

**Partnership** is an association formed by two or more people to carry on a business. The people usually agree either in writing or verbally to become partners. But people who run a business together and share the profits are usually considered partners, even if they do not intend to be.

The precise definition of a partnership and the rules by which it operates, vary from country to country. In most countries a partnership may consist of individuals or companies, or a combination of both. The number of partners is usually limited. In India, Malaysia and Ireland, for example, only two to twenty people may be partners. In India, the number is limited to ten if the business is banking.

**Rights and responsibilities of partners.** All partners have equal rights and obligations in running the business, unless they have agreed on another arrangement. Any disagreement that arises among them is decided by majority vote. Usually anything a partner does that seems to be carrying on the business in the normal way is binding on the other partners.

All partners share in the profits of the business, but they do not necessarily share equally. The size of each share is agreed upon when the partnership is set up. It depends on how much money or property each contributes to get the business started, and on the kind and amount of work each is to do. Every partner is expected to devote time to the business. If one does more work than the others, the partners may agree to pay that person a salary in addition to a share of the profits. Unless a system for sharing the debts of the partnership is set up formally, partners are expected to share partnership debts equally.

All partners are liable for any debts acquired by the business. These debts are normally paid out of funds or property belonging to the business. If they cannot be paid in this way, any other property of a partner can be taken by the people to whom the debt is owed. A person can lose much money by belonging to a partnership that fails. To avoid such loss, many countries allow *limited partnerships.* A *limited partner* may not take an active part in running the business, but is liable only for the amount of money he or she has invested. If a person wants to take part in running a business and still not risk losing more than he or she has invested, that person must join or form a company. See **Corporation; Company.**

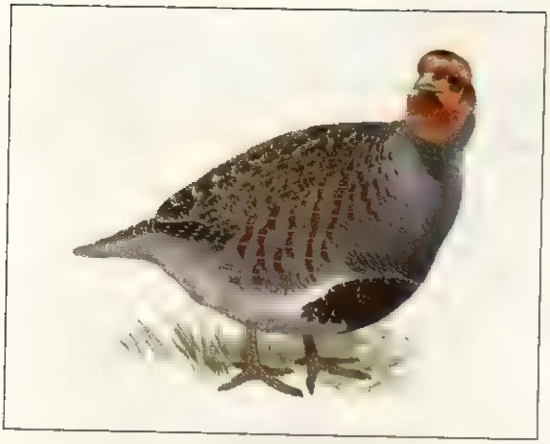
**Changing or ending a partnership.** No new partner may be taken into the partnership without the consent of all the members. A new agreement must then be made, stating what the new partner must contribute and what will be his or her share of the profits. A person who wishes to leave the business can agree with the other partners on a price for buying him or her out. If they cannot agree, that person may have the business closed down and the property sold in order to take his or her share in cash. When a partner dies, people named to handle the estate have the same rights.

Partnerships are a common form of organization for the professions. Many firms of solicitors and accountants for example, are partnerships. Since such people are selling their skills rather than buying and selling goods, they do not have to invest large sums of money to finance the business. In the United Kingdom, partnerships are generally limited to a maximum of twenty partners, but this does not apply to some professional firms. Partnerships are also suitable for small businesses such as shops where a large amount of capital is not required.

**Parton, Dolly Rebecca** (1946-     ), an American country and pop music singer and songwriter, became a top entertainer in the 1970's. Dolly's clear, plaintive voice, "blonde bombshell" appearance, and stage talent, attracted many fans.

Born of a poor family at Locust Ridge, in the mountains of Tennessee, U.S.A., Dolly Parton was one of 12 children. A child prodigy, she composed music before she could read or write. By the age of 10 she was making regular radio and television appearances in Knoxville, Tennessee.

Dolly Parton partnered country music star Porter Wagoner for 7 years from 1967. Her first great hit came in 1970, with "Joshua". In later years, Parton tended to desert her country music roots in order to broaden her appeal with pop- and rock-oriented offerings. Her best-selling albums included *My Tennessee Mountain Home* (1973), *Jolene* (1974), and *Love Is Like A Butterfly* (1974). She also starred in successful films.



**The common partridge** of Europe lives in open areas, sheltering in hedges or bushes.

**Partridge** is a stocky, medium-sized game bird. Although native to Europe and Asia, partridges have been widely introduced into other countries.

The European *common partridge* lives in open country, where it uses hedges and bushes for shelter. It is about 30 centimetres long, and has plumage that gives good camouflage against earth and grassland. It has an orange-brown face and a grey-brown body. The female lays a clutch of up to 15 eggs in a scrape at the base of a hedge or clump of grass. The common partridge forages for seeds and insects in family groups called *coveys*. It has a loud, harsh alarm call.

*Rock partridges* lives in dry regions of southern Europe and Asia. They have a bright red bill and legs. Many other species of partridges live in Southeast Asia, especially in forested areas. Most of these have dark, often iridescent plumage, broken up by lighter patches.

The *crested wood partridge* of Malaysia, for example, is glossy black with a white patch on the crown. The male has a maroon crest, red skin around the eye, and a red patch on the bill.

**Scientific classification.** Partridges belong to the pheasant family, Phasianidae. The common partridge is *Perdix perdix*. Rock partridges belong to the genus *Alectoris*. The crested wood partridge is *Rollulus rouloul*.

See also **Quail; Bird** (picture: How birds feed).

**Partridge, Eric** (1894-1979), was an expert in the study of the English language. He is noted for his *Usage and Abusage: A Guide to Good English* (1947). His other works include *Dictionary of Slang and Unconventional English* (1937), *Dictionary of Clichés* (1940), and *Dictionary of the Underworld* (1950). Partridge was born at Gisborne, in New Zealand. He was educated at Queensland University, in Australia.

**Parts of speech** are the word categories of the English language. Words belong to the same category if they show the same formal features or if they share a common function or position in a sentence. Both *table* and *man* are nouns because they show the possessive form *(table's, man's)* and the plural form *(tables, men)* by inflection (see **Inflection**). Both *table* and *man* can also fill a position in a sentence like "The ______ is big." Nouns, verbs, adjectives, and adverbs can be defined by formal features, function, and position. Other parts of speech, such as prepositions and conjunctions, have no formal features. They can be identified by their function and position in a sentence.

The parts of speech are not rigid categories. Many words can undergo a *functional shift*. For example, a noun like *television* placed in an adjective position (a *television* set) acts as an adjective. But it does not have the formal features of an adjective. For example, it cannot be compared like *high, higher*, and *highest* to become *television, televisioner*, and *televisionest*. The shifting nature of the parts of speech permits people to find new uses for established words.

Scholars differ on how to describe parts of speech. The traditional description lists eight classes: nouns, pronouns, verbs, adjectives, adverbs, prepositions, conjunctions, and interjections. Some scholars prefer to distinguish *form classes*—nouns, verbs, adjectives, and adverbs—from *function words*—prepositions, determiners, auxiliaries, and conjunctions. Others distinguish *inflected classes*—nouns, pronouns, verbs, and adjectives—from all other words, called *particles*.

See the separate articles on each part of speech, such as **Verb**. See also **Article; Parsing.**

**Party, Political.** See **Political party.**

**Parvovirus.** See **Canine parvovirus.**

**Pasay** (pop. 366,623) is a city on Luzon Island, south of Manila in the Philippines. Pasay stands on the shore of Manila Bay, and is bounded by Manila and the town of Paranaque. It now forms part of the National Capital Region. For location, see **Philippines** (map).

Pasay is home to the Philippines Air Force complex stationed at Nicholas Air Base. The domestic airport for Manila is also located in the city.

The Taft Avenue Extension links Pasay with Manila. In earlier times, it was called the Avenida Mexico and was the road to Cavite. During that period, the galleon trade between Manila and Acapulco in Mexico used Pasay as a port of entry and departure. The city was chartered in 1947 under the name of Rizal. In 1950 it returned to its original name of Pasay. See also **Philippines, History of.**

**Pascal,** a unit in the metric system, is used to measure pressure (force per unit of area). Its symbol is Pa. One pascal is the pressure of a force of 1 newton acting on an area of 1 square metre (see **Newton**). If a force of 30 newtons acts on an area of 5 square metres, the amount of pressure exerted is 6 pascals. Other metric units of pressure are the *kilopascal*, which equals 1,000 pascals, and the *bar*, which equals 100,000 pascals. In the customary, or English, system, pressure is measured in pounds per square inch. One pascal equals about 0.000145 pound per square inch. The pascal was named for the French scientist and philosopher Blaise Pascal.

**Pascal, Blaise** (1623-1662), was a French physicist, mathematician, and philosopher. He became known for his experiments with fluids in physics and for his work on probability theory in mathematics. In *Provincial Letters*, he helped create a modern French prose style.

Pascal's important work on the pressure of fluids produced the principle called *Pascal's law*. This principle, developed in the 1650's, states that fluid in vessels transmits pressures equally in all directions. Pascal's law explains the operation of air compressors, vacuum pumps, and hydraulic lifts, jacks, and presses (see **Pascal's law**).

Pascal's experiments also helped prove that air has weight and that air pressure can produce a vacuum. At the time, many scientists doubted that a vacuum could exist.

In the 1650's, Pascal and French mathematician Pierre de Fermat pioneered work in probability theory and discussed some of its applications to gambling. In 1654, Pascal devised a triangular arrangement of numbers in which each number is the sum of the two numbers to the right and left of it in the row above. This arrangement, called *Pascal's triangle,* can be used to calculate probabilities (see **Permutations and combinations** [History]). Pascal also invented a calculating machine that performed addition and multiplication.

Pascal was born in Clermont-Ferrand, France. He showed brilliance as a mathematician while still a boy. Pascal became absorbed in a religious movement called Jansenism and, in late 1654, he entered a Jansenist convent at Port-Royal (see **Jansen, Cornelius**). The Jesuit religious order charged the Jansenists with heresy and condemned Jansenist leader Antoine Arnauld. In reply, Pascal published 18 immensely popular satirical pamphlets called the *Provincial Letters* in 1656 and 1657.

From 1658 until his death, Pascal worked on a defence of Christian faith. Fragments of this uncompleted work were discovered after his death and published as *Pensées.* This work expresses Pascal's belief that there are limits to the truths reason can know, and that faith from the heart in Christian revelation is the primary guide to truths.

See also **French literature** (Classical prose).

**Pascal's law,** also called *Pascal's principle,* describes the effect of applying pressure on a fluid in a closed container. It states that pressure applied to an enclosed fluid is transmitted with equal force throughout the container. The law explains why a thin-walled bottle filled with water and fitted with a cork may break when the cork is pushed down. Pascal's law was named after Blaise Pascal, a French scientist and mathematician of the 1600's. See also **Hydraulics; Pascal, Blaise.**

**Paschal II** (?-1118) was elected pope in 1099. Much of his troubled reign was occupied with the *investiture controversy.* The controversy was a quarrel over whether secular powers or the clergy had the right to *invest* (appoint) the clergy to religious offices.

In 1105, Paschal decided to support Henry V in Germany in a revolt against his father, Henry IV. In 1111, after his father's death, Henry V promised to support Paschal's plan for settling the investiture issue and, in return, the pope agreed to crown Henry as emperor. In Paschal's plan, the clergy would give up their secular powers and influence in the hope that secular leaders would leave investiture to church officials.

Paschal's plan collapsed in a storm of protest from the German clergy and nobility. Henry then kidnapped the pope and forced him to carry out the coronation. Henry also forced an agreement on investiture favourable to the imperial position. A few years later, Paschal renounced the agreement. Paschal was born in Italy. His real name was Rainerus.

**Pasmore, Victor** (1908- ), is a British painter best known for his abstract compositions. They include *Rectangular Motif* and *Inland Sea,* which hang in the Tate Gallery, in London. Pasmore was born at Chelsham, in Surrey, and educated at Harrow School, near London. As a member of the Euston Road Group, he painted many fine representational pictures, such as his views of the River Thames. After World War II, he turned to abstract painting.

**Paspalums** are types of grass that grow naturally in tropical places and temperate America. Several species have agricultural uses. *Dallis grass* is grown as a summer pasture grass in areas of high rainfall in South Africa. In Australia, it is grown especially in the dairying country of New South Wales and Victoria, and the Queensland tablelands. *Bahia grass* has been introduced to the southern United States as a fodder and lawn grass. *Koda millet* is a type of paspalum grown extensively in India as an animal feed. *Water couch* is a paspalum that grows in swampy areas and is planted as a fodder grass in warm coastal areas.

**Scientific classification.** Paspalums belong to the grass family, Gramineae (Poaceae). They are genus *Paspalum.* Dallis grass is *P. dilatatum,* Bahia grass is *P. notatum,* Koda millet is *P. scrobiculatum,* and water couch is *P. distichum.*

**Pasqueflower** is the name of small plants related to anemones, with large flowers that open early in the spring. The name *pasqueflower* means *Easter flower.* Two species of pasqueflower grow in Europe and one in North America. Its flowers range in colour from lavender to deep purple and have yellow centres. The flowers form on very short stems that grow longer as the seeds ripen. The fuzzy leaves have many leaflets that spread out like the fingers of a hand. Pasqueflowers differ from anemones in having large plume-like seed heads. They grow mainly in areas of short grassland such as the steppes of central Europe and the Soviet Union. Some species grow on mountains. There are several garden varieties.

**Scientific classification.** Pasqueflowers belong to the anemone family, Ranunculaceae. The common European pasqueflower is *Pulsatilla vulgaris.*

See also **Flower** (picture: Flowers of prairies and dry plains).

**Pass.** See **Mountain pass; Jetty.**

**Passenger pigeon** is an extinct bird that was formerly abundant in eastern North America. The last known passenger pigeon died in 1914 at the Cincinnati Zoological Gardens, Ohio, U.S.A. Its body is now displayed at the National Museum of Natural History in Washington, D.C.

The male passenger pigeon was about 42 centimetres long, with a long pointed tail; a short, black bill; and red eyes and feet. It had a grey-blue head and body. The feathers on its neck and throat were wine-coloured, with a green and purple tint. The female was similar but was smaller and had duller colours.

Scientists estimate that as many as 3 billion to 5 billion passenger pigeons lived across eastern North America in the year 1500. The birds got the name *passenger pigeon* because they travelled often to new places to look for food. They flew rapidly, sometimes in groups of several million.

Passenger pigeons nested chiefly in forests of oak and beech, and ate mostly acorns and beechnuts. These birds gathered in enormous breeding colonies, which covered an area of over 75 square kilometres. Females laid only one egg each spring.

The great number of passenger pigeons began to decline in the 1850's. Many beech and oak forests were cut for use as fuel and timber and to clear land for farms. As a result, much of the passenger pigeon's habitat was destroyed. Hunters also killed millions of nesting passenger pigeons for food. They shipped the birds by the barrelful to cities. These factors, combined with the bird's low reproductive rate and inability to nest in smaller colonies, doomed the bird to extinction.

**Scientific classification.** The passenger pigeon belongs to the pigeon family, Columbidae. It is *Ectopistes migratorius.*

See also **Audubon, John J.** (picture).

**Passion music** is a vocal composition that dramatically tells the Gospel story of the suffering and Crucifixion of Jesus Christ. Passion music may involve a large chorus with instrumental accompaniment or just a few singers representing characters from the Gospels. Passion music is generally performed during Holy Week—that is, from Palm Sunday to Easter Sunday.

Passion music existed as early as the A.D. 300's. It probably originated from the church custom of reciting the Gospel stories of Christ's last days. By the 1600's, it had developed into an elaborate dramatic musical form similar to the *oratorio.* One of the most famous works of this type is *The Passion According to St. Matthew* (1729) by the German composer Johann Sebastian Bach. It includes *recitatives* (solo passages sung in a speechlike style), *arias* (vocal solos in songlike form), choruses, and orchestral passages.

See also **Oratorio.**

**Passion play** is a dramatic performance that presents the death and resurrection of a god. The ancient Egyptians performed passion plays devoted to the god Osiris. The ancient Greeks presented similar plays dedicated to the god Dionysus. But the term *Passion Play* most often refers to plays that depict the suffering, Crucifixion, and Resurrection of Jesus Christ.

European townspeople and villagers of the late Middle Ages often staged Passion Plays. The plays enabled them to participate personally in the drama of Jesus' last days on earth.

**A passion play** dramatizes the Crucifixion and Resurrection of Jesus Christ. Passion plays are often performed in outdoor theatres.

**The passionflower** reminded early Roman Catholic missionaries in America of Christ's Passion, and they gave it this name.

Several towns in southern Germany, western Austria, and Switzerland continue the Passion Play tradition today. The most famous European Passion Play is presented by the town of Oberammergau in southern Germany. This play originated in 1634 as a show of thanks to God for sparing the town from a plague. The Oberammergau Passion Play normally is performed every 10 years. It lasts about $5\frac{1}{2}$ hours and includes over 800 performers (see **Oberammergau** [picture]).

**Passionflower** is a woody vine that has unusual blossoms. Roman Catholic priests of the late 1500's named it after the *Passion* (suffering and death) of Jesus Christ. They believed that several parts of the plant, including the petals, rays, and sepals, symbolized features of the Passion. The flower's five petals and five petal-like sepals represented the 10 apostles who remained faithful to Jesus throughout the Passion. The circle of hairlike rays above the petals suggested the crown of thorns that Jesus wore on the day of His death.

The priests who named the vine found it growing in what is now Latin America. Today, gardeners in many parts of the world grow passionflowers for their unusual flowers. The flowers may be almost any colour. They range from about 2 to 15 centimetres across.

Many species of passionflowers bear a fruit that is called passionfruit or granadilla. These fruits taste slightly sour or very sweet, depending on the species. Farmers in Australia, Mexico, Hawaii and the southern United States grow juicy, plum-sized, purple or yellow passionfruit. The sweet calabash of the West Indies is cultivated for its grape-flavoured juice. The giant grenadilla is widely cultivated in tropical America. It has large yellow fruits up to 20 centimetres long.

**Scientific classification.** Passionflowers belong to the passionflower family, Passifloraceae, and make up the genus *Passiflora.* The passion flower most widely cultivated for its juice is *P. edulis.* The sweet calabash is *P. maliformis,* and the giant grenadilla is *P. quadrangularis.*

**Passive voice.** See **Voice** (in grammar).

**Passover** is a Jewish festival that celebrates the flight of the Israelites from Egyptian slavery, probably in the 1200's B.C. The story of Passover is told in the Bible in

Chapter 12 of the Book of Exodus. Passover begins in March or April, on the 15th day of the Hebrew month of Nisan. Most Jews celebrate Passover for eight days, but Jews in Israel, and Reform Jews in other countries, celebrate it for seven days.

Jews celebrate Passover in their homes at a ceremonial feast called the Seder. At the Seder, the story of the flight of the Israelites is read from a book called the Haggadah. In addition, foods symbolizing the flight from Egypt are placed on the table. The most important symbol is *unleavened* (unraised) bread called *matzah*. According to the Bible, when the Israelites fled, they did not have time to let their bread rise. They made flat, unleavened bread instead. Therefore, Jews eat matzahs instead of leavened bread during Passover.

The word *Passover* comes from the Biblical story of the 10th plague, which God brought on Egypt for keeping the Israelites in bondage. The story says God killed the first-born child in every Egyptian home but passed over the homes of the Israelites. The word *Passover* also refers to the passing over of the Israelites from slavery to freedom.

See also **Religion** (picture).

**Passport** is a travel document that identifies the holder as a citizen of the country by which it is issued. A passport also requests other countries to give the holder safe passage and all lawful aid and protection. Sometimes a passport must have a *visa* (official endorsement) from the country a person desires to visit before entry into that country is permitted (see **Visa**).

Passports are issued by governments through passport offices. A person applying for a passport has to fill in a form and provide evidence of identity, such as a birth certificate. The passport form may require the signature of a witness, such as the family doctor, lawyer, or some other official person who knows the applicant personally. A passport contains a photograph of the holder, and details such as his or her full name, date of birth, and country of residence. Inside the passport are blank pages which may be stamped by officials in the countries visited by the passport holder.

Different kinds of passport are available in some countries. In the United Kingdom, for example, a person may either have a passport valid for ten years, or a simpler document called a *visitors' passport*. This simpler passport is valid for only one year, and covers short visits to certain countries, including other members of the European Community.

In many countries, children below the age of 16 do not need separate passports. Such children are included on the passport of their mother or father.

**Pasta** is a food made chiefly from flour and water. It comes in more than 100 shapes and sizes. Some of the best known are macaroni, which consists of hollow tubes; spaghetti, which is made into long cords; and noodles, which are flat strips. Elbow macaroni has the shape of short, curved tubes, and shell macaroni resembles sea shells. Vermicelli is extremely thin spaghetti, and wide noodles are called lasagna noodles. Ravioli, another pasta product, consists of small, hollow squares that are stuffed with cheese or minced meat.

The word *pasta* is an Italian term meaning *dough*. The best pastas are made with *durum* (hard-grain) wheat flour. Manufacturers mix this yellowish, high-protein

**Pasta** is produced in long, solid cords, hollow tubes, flat strips, and many other different shapes and sizes. Pasta products are rich in carbohydrates and are also a source of protein.

flour with water to form a firm dough. The dough is either pressed through a machine or rolled out and cut into the proper shapes. The pasta can then be dried with forced air until it is hard and brittle.

Pasta products are rich in *carbohydrates* (starches) and are a fairly good source of protein. The flour used for pasta is often enriched with iron and the B vitamins thiamine, riboflavin, and niacin. Some pastas include such ingredients as whole wheat, oil, and seasonings in addition to flour and water. Manufacturers add eggs to the pasta mixture to make egg noodles. *Green pasta* is made by mixing spinach with pasta dough.

Pasta dishes have been a speciality of Italian cooking since the 1200's, but they are now popular throughout the world. The bland flavour of pasta makes it a suitable ingredient to mix with cheese, meat, tomato sauce, and other foods. Pasta is boiled until it is soft but slightly chewy. It can then be combined with other foods in casseroles or salads.

**Pastel.** See **Painting** (Pastels).

**Pasternak, Boris** (1890-1960), was a Russian poet and fiction writer. He is best known for his novel *Dr. Zhivago* (1957). Pasternak was awarded the Nobel Prize for literature in 1958. He accepted the award but then rejected it under pressure from the Soviet government.

Authorities banned *Dr. Zhivago* in the Soviet Union. The novel was first published in Italy and then was translated into English and many other languages. Zhivago, a Russian doctor, experiences the suffering and disorder of his country's revolutionary period. He cannot accept Communist rule and tries to find happiness in love and in the beauty of nature.

Boris Leonidovich Pasternak was born in Moscow. He first studied music and philosophy. His first collection of poetry, *A Twin in the Clouds*, was published in 1914. His third book of poems, *My Sister Life* (1922), established his reputation as a major Russian au

Pasternak's poems supported the Russian revolutions of 1905 and 1917, but he did not accept many of the strict doctrines of the Communist Party. During the 1930's and 1940's, the Soviet government prohibited the publication of most of Pasternak's writing. He earned a living by translating poems and plays by foreign writers, including Johann von Goethe and William Shakespeare. In 1957, the Soviet Writers Union expelled Pasternak, which meant that his works could not be published in the Soviet Union. The union reinstated him in 1987, almost 27 years after his death. In 1988, *Dr. Zhivago* was published in the Soviet Union for the first time.

**Pasteur, Louis** (1822-1895), a French scientist, made major contributions to chemistry, medicine, and industry that have greatly benefited humanity. His discovery that diseases are spread by bacteria saved countless lives. Pasteur was a great theoretical scientist who applied his basic discoveries to important practical problems in both industry and medicine.

**His work in chemistry** brought him his first recognition. By the age of 26, Pasteur was famous for his work on the structure of crystals. But Pasteur soon started probing the mysteries of *bacteriology* (the study of bacteria). Others saw bacteria before Pasteur did. But he was the first to show that living things come only from living things. Before that, many scientists believed in *spontaneous generation,* a theory that life could come from things that are not alive, such as dirt. Pasteur also showed that although bacteria live almost everywhere, their spread can be controlled. See **Bacteria; Spontaneous generation.**

**His work in industry.** Pasteur is credited with saving the silk industry and wine industry in France. In the early 1860's, he noted that wine turns bitter because of *microbes* (germs) that enter the wine while it is being made. He showed that microbes can be killed by applying controlled heat. This use of heat as a means to kill germs became known as *pasteurization.* Pasteur also used this method to preserve milk and beer, and to preserve food. See **Pasteurization.**

**Louis Pasteur**

In 1865, Pasteur set out to help the silk industry. A disease called *pebrine* was killing great numbers of silkworms. He worked for several years to prove that a microbe that attacks silkworm eggs causes the disease. He showed that eliminating this germ in silkworm nurseries would wipe out the disease.

**His work in medicine.** Pasteur proved that many diseases are caused by germs that multiply in the body. He also proved that if microbes are weakened in a laboratory and then placed in an animal's body, the animal develops an *immunity* (resistance) to the microbe. He called this method of fighting off microbes *vaccination.* Pasteur proved the value of vaccination by vaccinating sheep against a disease called anthrax. He also showed that vaccination could be used to prevent chicken cholera and other animal diseases. See **Anthrax.**

Pasteur began in 1881 to study rabies, a deadly disease spread by the bite of rabies-infected animals. He spent endless hours in his laboratory seeking a vaccine to prevent the disease. One day in 1885, a small boy named Joseph Meister was bitten by a rabid dog. The boy's parents begged Pasteur to save their son. Pasteur hesitated to use his new vaccine on a human, but he finally agreed. After several anxious weeks of treatment, the vaccine proved successful. The boy did not get rabies. See **Rabies.**

**His life.** Pasteur was born on Dec. 27, 1822, in Dôle, France. He was the son of a tanner. The family moved to Arbois, where he received his early education. Pasteur was a slow but careful student who showed a talent for art. He later studied chemistry at the École Normale Supérieure in Paris.

In 1849, Pasteur became a chemistry professor in Strasbourg, France, where he began studying *fermentation,* a type of chemical breakdown of substances by microbes (see **Fermentation**). His work brought such improvements in brewing and winemaking that some say France was able to save enough money to pay its Franco-Prussian War debt.

Pasteur became director of scientific studies at the École Normale in 1857, but he left this post in 1867 to focus on his research. In 1868, a brain stroke partially paralysed Pasteur. Despite his poor health, he continued his work. The Pasteur Institute in Paris, a world centre for the study, prevention, and treatment of disease, was founded in 1888 in gratitude to him. He served as director of the institute until his death in 1895. Pasteur is buried in a magnificent tomb in the building.

**Pasteurization** is a method of preserving food. It is most commonly used for milk, but may also be used for beer, cheese, eggs, and other foods. Pasteurization kills bacteria and other harmful organisms present in food. It involves heating food at specific temperatures and for certain periods of time.

Pasteurization is named after Louis Pasteur, a French scientist. In the mid-1800's, Pasteur discovered that bacteria in wine and other foods multiply quickly and cause spoilage. He found that gently heating wine would destroy most of the bacteria without altering the flavour of the wine.

See also **Milk** (At a processing plant).

**Paston letters** are the correspondence of the Paston family, landowners in Norfolk, England, during the 1400's. The letters are a rich source of information on the period from 1422 to 1509. They describe the Pastons' troubles with feudal lords made more powerful by the unrest caused during the Wars of the Roses. The letters also give details of economic affairs and of domestic life among the wealthier English middle classes. James Gairdner edited *The Paston Letters* in 1904.

**Pastry** is baked from a stiff, short dough that is composed basically of flour, salt, shortening, and water. This dough is baked into plain, flaky, or puff pastries.

Different countries are noted for special kinds of pastry. French pastry is made from a puffy dough like that used for éclairs and cream puffs, or from a cake mixture cut into small shapes and decorated elaborately with icing, glazed fruits, jams, or nuts. Danish people make pastries of flaky yeast dough into which generous amounts of butter have been folded.

**Pasture** is land from which cattle, horses, sheep, and other livestock and wildlife get their food by grazing. Such food usually costs farmers less than rations of hay, grain, and other harvested crops. In regions of rich grassland, animals may get all their food from pastures. But most livestock thrive better when fed other and richer feeds in addition to pasturage.

The world has many great pasture and rangeland areas. The best areas are usually found in those parts of the temperate regions where the rainfall is moderate. About six-tenths of the land area of the United States is used for pasture and range during part of every year. Other countries with large pasture or range areas include Argentina, Australia, Brazil, China, Russia, and South Africa. Grassland areas may be known by such names as *velds, savannas, steppes,* and *pampas.* The chief plants used as pasturage are alfalfa, grasses, clovers, and similar plants. Many farmers improve their pastures by fertilizing and seeding them, or create improved pastures from tilled fields or open forest land.

See also **Grassland; Pampa; Savanna; Steppe.**

**Patagonia** is a region in southern South America. Most of the region is desert. Indians lived in Patagonia long before white people arrived. The name *Patagonia* comes from a Spanish word that means *big feet.* The Indians were tall and wore large boots stuffed with grass.

In 1520, the Portuguese navigator Ferdinand Magellan became the first European to reach the region. In 1865, Welsh settlers came into Patagonia. The area was divided between Chile and Argentina in 1907 under the terms of an 1881 treaty.

Today, the term *Patagonia* usually refers to the Argentine section of the region. It includes the southern Argentine provinces of Río Negro, Chubut, and Santa Cruz, and the territory of Tierra del Fuego. Farmers raise sheep on large tracts of land in the region. Hydroelectric projects on the Limay River in northern Patagonia provide electricity. Oil fields in Patagonia yield much of Argentina's petroleum. The region also has coal and iron ore deposits.

See also **Argentina** (Patagonia; terrain map).

**Patchouli** is a strongly fragrant oil used in making perfumes. The oil comes from leaves of the patchouli plant, a member of the mint family. The leaves are dried in the sun. They are sometimes allowed to undergo *fermentation* (a chemical change that breaks down certain materials). Steam is then passed through the leaves to remove the oil. Farmers grow patchouli plants in China, India, Indonesia, the Philippines, and Singapore.

**Patella.** See **Knee.**

**Patent** is a document issued by a national government granting an inventor exclusive rights to an invention for a limited time. A patent allows an inventor to prevent others from making, selling, or using the invention in the country that granted the patent.

To be eligible for a patent, an invention must be new, useful, and original. Inventions include machines, methods, manufactured products, compositions, and new uses of inventions in each of these categories. Improvements on inventions can also be patented.

An invention that would be obvious to anyone of ordinary skill in a given field cannot be patented. Such an invention might involve merely a substitution of materials, a change in the size of a machine, or a combination of known concepts without new and unexpected results.

**How patents protect inventors.** A patent gives the inventor a legal monopoly of an invention for a limited time. In most countries this is between 16 and 20 years, but in some countries there is a shorter period for particularly useful inventions. Once a patent has been applied for, a lengthy examination may be carried out to determine whether or not the invention is original.

To avoid delay in getting a newly invented product on the market, many manufacturers start to produce it after filing for a patent. The manufacturer marks the product "Patent Pending" or "Patent Applied For." This warning has no legal value, but it discourages imitation. A patented invention may be marked "Patented," together with the patent number. Copying a patented invention without permission is called *infringement.* The patent owner may sue for damages and an injunction to order the infringer to stop copying the invention.

**Pastry** can be used in many different ways. Danish pastries, *above,* may be filled with custard, fruit, or nuts.

**Patagonia** is a region of South America. A large part of Patagonia is made up of desert, or grassy plains called pampas, *above.*

An inventor may sell all or part of the rights given by a patent. The inventor may also license these rights to a manufacturer. Licensing gives the inventor a fee or *royalties* (payments based on sales), or both.

### National patents

Patent laws vary from country to country. Most patent laws follow the principle that a patent is a bargain between the inventor and society. Inventors reveal their secrets in exchange for a monopoly for a limited time. Society receives the benefit of sharing their secrets.

Differences in the patent laws of various countries include the period a patent remains in force. The laws also vary on the conditions under which applicants may make public their inventions before receiving a patent. Some governments force the patent owner to grant licenses. Others force mandatory licensing if the invention is not manufactured in the country within a certain period after the patent has been granted.

**International patent agreements.** A patent treaty now recognized by almost 100 nations went into effect in 1884. Each nation agrees to give citizens of the other countries the same rights to obtain a patent as it gives its own citizens. The treaty established a principle that is called the *right of priority.* This principle benefits people who apply for a patent in their own country and then apply in any of the other countries within a year. Their later applications are considered as having been made on the same date as the one made in their own country.

In 1978, a second patent agreement, the Patent Cooperation Treaty (PCT), took effect. It provides for a search and a standard application form. Under this treaty, each nation retains its own patent laws, but the standard application replaces an individual nation's application. The international application is given the same treatment as the national application. Each country then largely relies on the PCT search. The PCT has been signed by more than 30 countries or groups of countries.

Also in 1978, a number of European nations established the European Patent Office. By filing an application with this office, an inventor can have his or her invention patented in any one or more of the member countries. Previously, inventors had to file a separate application in every member country in which they wanted protection.

**Patent leather.** See **Leather** (Final processing).

**Pater, Walter Horatio** (1839-1894), an English essayist and critic, influenced the artistic taste of many Englishmen in the late 1800's. Pater's most important and best-known work is the philosophic novel *Marius the Epicurean* (1885). It tells the story of a young man in ancient Rome who admires beauty for its own sake. The novel was important in establishing the doctrines of *aestheticism,* the belief that beauty is the most meaningful thing in life. Pater's other notable work is a collection of essays on Renaissance artists, *Studies in the History of the Renaissance* (1873).

Pater was born in London and graduated from Oxford University in 1862. He was elected a *fellow* (resident teacher) of Brasenose College at Oxford in 1864. The college was the centre of his activities for the rest of his life. He began his career as a critic writing essays on art for two famous English magazines—the *Fortnightly Review* and *The Westminster Review.*

**Paterson, Banjo** (1864-1941), was the pen name of Andrew Barton Paterson, an Australian poet, lawyer, and grazier. He is generally believed to have written the words of one of Australia's most popular songs, "Waltzing Matilda."

**His life.** Paterson was born at Narambla, near Orange, New South Wales. His home was Illalong Station in the Yass district. Literary pursuits helped relieve the isolation of station life. Both his father and sister published verse in *The Bulletin* (see **Bulletin, The**). Paterson's maternal grandmother wrote poetry for private circulation. Paterson's father, who was Scottish, introduced his son to the traditional Scottish ballads. The influence of these traditional songs can be seen in Paterson's bush ballads.

**Banjo Paterson**

Paterson attended Sydney Grammar School, but spent holidays on the station. There he enjoyed all the activities that later provided the material for his writing. At the age of 16, Paterson became a solicitor's clerk. He later became a partner in the law firm of Street and Paterson. His poetry gained immediate popularity when it was published by *The Bulletin.* Paterson virtually abandoned law for writing and journalism.

He was a war correspondent in South Africa in 1899 and later visited China and England. Paterson returned to Australia in 1902 and lectured for a time on the Boer War. Later, he worked as a newspaper and magazine editor. He eventually became a grazier. He drove ambulances in France and also served in Egypt during World War I. He was made a C.B.E. in 1930.

**As a writer,** Paterson was popular and prolific. Critics consider him to be Australia's best bush balladist. He published his first ballad, "Clancy of the Overflow," in 1889. He followed it with another ballad, "The Man from Snowy River" (1895). From then until the 1930's, Paterson published ballads and lyric poetry, as well as two novels and a book of stories. He also made another important contribution to Australian literature. He gathered and published the first collection of Australian folk ballads, entitled *The Old Bush Songs* (1905). Most of these songs, which had been composed and sung during pioneering days, had never been written down.

Paterson's work is cheerful and optimistic in outlook. It clearly reflects his affection for Australia and Australians. In this respect, Paterson differs from Henry Lawson (see **Lawson, Henry**). Lawson's life was less fortunate, and his ballads tend to stress tragic aspects of bush life. The two balladists criticized each other's points of view. Paterson makes his attitude clear in *An Answer to Various Bards,* where he refers to Lawson as "a sad and soulful poet."

Paterson's ballads introduce shearers, drovers, and squatters. Each displays the individuality that Paterson sees as typical of the outback character. Paterson was primarily a storyteller. His work shows the influence of early ballads and of the British writer Rudyard Kipling.

But Paterson used Australian material to produce a new type of Australian verse. His longer narrative poems have swinging, vigorous action; a cheerful, if somewhat idealized setting; and endearing characters.

"The Man from Snowy River" appeared in 1895. This poem combines humour and adventure and is typical of the spirit of Paterson's poetry. The exciting ride of an unlikely hero on an unlikely horse ends with these lines:

And down by Kosciusko, where the pine-clad
ridges raise
Their torn and rugged battlements on high,
Where the air is clear as crystal, and the white
stars fairly blaze
At midnight in the cold and frosty sky,
And where around the Overflow the reed-beds
sweep and sway
To the breezes, and the rolling plains are wide
The Man from Snowy River is a household
word today,
And the stockmen tell the story of his ride.

"Clancy of the Overflow," published in 1889, shows less concern for action than mood. It expresses the nostalgia of a city dweller for his old life in the bush with Clancy. Clancy, who is mentioned elsewhere in Paterson's work, typifies the bush hero:

In my wild erratic fancy visions come to me
of Clancy
Gone a-droving "down the Cooper" where the
western drovers go;
As the stock are slowly stringing, Clancy rides
behind them singing.
For the drovers' life has pleasures that the
townsfolk never know
And the bush has friends to meet him, and
their kindly voices greet him
In the murmur of the breezes and the river on
its bars,
And he sees the vision splendid of the sun-lit
plains extended,
And at night the wondrous glory of the ever
lasting stars.



Some of Paterson's poems, such as *A Bush Christening* and *The Man from Ironbark*, are quite humorous. He most often used humour of situation, as in *Father Riley's Horse*. Critics no longer find Paterson's prose very interesting. He wrote some patriotic verse and a children's poetry collection, *The Animals Noah Forgot*.

**Paterson, William** (1755-1810), a British soldier, became an administrator in Australia. He was born in Scotland. He landed in Sydney in 1791 as a captain in the New South Wales Corps. After sick leave in England, he returned to Sydney in 1799 with orders to stop the trading activities of the corps. In 1804, he founded York Town in northern Van Diemen's Land (now called Tasmania). When Governor Bligh was deposed, Paterson was recalled to Sydney as administrator, serving until Governor Macquarie arrived. Paterson died on his voyage back to England.

**Pathans.** See **Pushtuns.**

**Pathfinder force** was formed within the British Royal Air Force in 1942, during World War II (1939-1945), under the command of the Australian airman Group Captain Donald Bennett. It was set up to provide an accurate system of target marking for the British bombing offensive. The aircraft in the Pathfinder force flew ahead of the main bomber stream and dropped flares and target indicator bombs on the target area. In this way, they provided a specific aiming point for the bombers.

**Pathology** is the study of disease processes or any condition that limits the power, length, or enjoyment of life. *Comparative pathology* compares human diseases with those of various animals. *Human pathology* is a branch of medicine. Pathologists use modern instruments and methods, such as electron microscopy, to help them recognize the changes caused by disease in the tissues and organs of the body. They try to explain why a diseased body acts differently from a normal body.

Pathologists use their knowledge of diseased tissues and body fluids to aid treatment. Pathological tests help doctors diagnose a disease and to establish the extent of its attack. These tests may include examination of the blood, urine, and tissues. The use of laboratory tests to diagnose disease is called *clinical pathology*.

Pathologists also study diseased parts removed by surgery. They may examine corpses to learn the exact cause of death. This examination is called an *autopsy*, or *post-mortem examination*.

Special kinds of pathology study diseases of separate organ systems. For example, *neuropathology* concerns diseases of the nerves.

See also **Gnotobiotics; Morgagni, Giovanni B; Virchow, Rudolf.**

**Patience** is the name of many card games that are played by one person. Patience is usually played with a deck of 52 cards. In the most popular kind of patience, the player deals seven cards in a horizontal row, the first one faceup, and the rest facedown. Then the player deals a card faceup on the second card, and a card facedown on each of the remaining five cards. The deal continues until all seven piles have a card facing up.

One faceup card may be moved on top of a second faceup card if it is one lower in rank and the opposite colour of the second card. Any cards that have been placed on the first card move with it to the second card.

Aces rank lowest and are put in a row above the main piles. The object is to stack all the cards by suits and in order in the top piles, from ace to king. The top card in any lower pile may be moved to the top row if it can be placed on the card ranking just below it in the same suit.

**In patience,** the player stacks the cards into piles by suit and in order, *top*, and by alternate colour and rank, *bottom*.

A facedown card that becomes the top card in a lower pile may be turned faceup. If a lower pile becomes empty, a king may be moved to the space. Undealt cards are turned over one at a time. Each is either played on a pile or placed faceup on a discard pile. The player may go through the deck only once.

**Patmore, Coventry** (1823-1896), was an English poet. In 1854, he published *The Bethrothal,* the first of four long poems. It was followed by *The Espousals* (1856), *Faithful for Ever* (1860), and *The Victories of Love* (1862). These poems made up Patmore's great theme on married love, which he called *The Angel in the House.* His other poetic works were *The Unknown Eros* (1877) and *Amelia* (1878). Patmore was born at Woodford, in Essex.

**Patmos** is a small volcanic island in the Aegean Sea, off the west coast of Turkey. It is one of the Dodecanese Islands. For location, see **Greece** (map). It was on Patmos that the author of the Book of Revelation saw his prophetic visions (see **Revelation, Book of**). The island covers about 34 square kilometres and has a population of 2,500. Almost all of the people depend for a living on tourism or the growing of citrus fruit and olives.

Patmos was ruled by Turkey from 1537 to 1912, when Italy gained control. It was formally given to Italy by the Treaty of Lausanne, in 1923. It was given to Greece in 1947.

**Paton, Alan Stewart** (1903-1988), was a South African writer best remembered for his novel *Cry the Beloved Country* (1948). In it he made a plea for greater racial understanding and cooperation. His works are highly critical of apartheid and show a deep concern for the injustices inherent in segregationist policies. His books helped alert the world to the issue of South Africa's long-standing racial inequality. See **Apartheid.**

Paton was born in Pietermaritzburg, South Africa, and was educated at the University of Natal. He became president of the South African Liberal Party before the party was banned in 1968. Paton was the principal of Diepkloof Reformatory in Johannesburg from 1935 to 1948. The post provided him with first hand experience of the prison system and segregated black living conditions, and he became an outspoken critic of his country's racial policies. Paton was frequently persecuted for his opinions and spent the final years of his life under house arrest.

In *Cry the Beloved Country,* Paton searches for a solution to the problem of apartheid. It describes the character of the Reverend Stephen Kumalo, and his journey to Johannesburg in search of his son. Paton contrasts the idealized rural world of the black clergyman with the stark reality of the urban ghetto. The novel became an international best seller and helped raise international awareness of the situation in South Africa.

**Patriarch** was the father or ruler of a family or tribe in ancient times. Abraham, Isaac, and Jacob were the patriarchs of the Hebrew nation. In later Jewish history, the president of the *Sanhedrin,* the highest governing council of the Jews, held the title of patriarch.

The early Christians used the title to honour the bishops of the largest and most important churches. The bishops of Rome, Alexandria, and Antioch were recognized as patriarchs in the early 300's. By the early 500's, the bishops of Jerusalem and Constantinople had come to be called patriarchs. In the Roman Catholic Church, the pope has the title *patriarch of the West.* Roman Catholic archbishops in some cities still hold the honorary title of patriarch. For example, cardinals hold the title in Alexandria and Antioch. The heads of some Eastern Orthodox Churches are called patriarchs. All Eastern Orthodox Churches regard the patriarch of Constantinople, called the *Ecumenical Patriarch,* as their spiritual leader.

See also **Eastern Orthodox Churches; Mormons** (Church organization).

**Patriarchal family.** See **Family** (Early families).

**Patricians** were aristocrats of the early Roman Republic (509-264 B.C.). The word *patrician* comes from the Latin word *pater* (father), which was used to describe members of the Roman Senate. Patricians belonged to wealthy families and were proud of their distinguished ancestors. They controlled the government, the army, and the state religion. They resisted the attempts of the *plebeians* (commoners) to share their power. Until 445 B.C., a plebeian could not marry a patrician.

The two classes struggled for power for more than 200 years. During this time, the plebeians increased in numbers and in wealth, and the number of patricians grew smaller. The patricians were forced to allow plebeians to hold more and higher positions. By 287 B.C., they could hold almost any civil or religious office, and could pass laws that affected everyone. The patricians and wealthy plebeians joined to form a new nobility, based on descent from high state officials.

Many patrician families died out during the late Republic (265-27 B.C.). Many emperors created new patricians, but the title was only an honour and carried no privileges.

See also **Plebeians.**

**Patrick, Saint** (about 389-461), is the patron saint of Ireland. Patrick was chiefly responsible for converting the Irish people to Christianity. He became known as the Apostle to the Irish. His name in Latin is Patricius.

**His life.** Patrick was born in Britain. His father was a wealthy alderman and a Christian. When Patrick was 16 years old, pirates captured him during a raid and sold him as a slave in Ireland. He served as a shepherd of an Irish chieftain in Ulster. During his captivity, Patrick dedicated himself to religion. He escaped after six years of slavery and returned to his home in Britain.

As a result of his experiences in Ireland, Patrick became driven by the idea of converting the Irish to Christianity. To prepare himself for that task, he studied in the monastery of Lérins, on an island off the southeast coast of France. Patrick also went to Auxerre, France, and studied religion under Saint Germanus, a French bishop. Partly because Patrick's earlier education was inadequate, his religious superiors were reluctant to let him return to Ireland as a missionary. But Palladius, the first Irish missionary bishop, died in 431. Pope Celestine I then sent Patrick to Ireland.

Patrick began his work in northern and western Ireland, where no one had ever preached Christianity. He gained the trust and friendship of several tribal leaders and soon made many converts. Patrick is said to have founded more than 300 churches and baptized more than 120,000 people.

Patrick brought clergymen from England and France for his new churches. He succeeded in his mission in

Ireland, even though many British clergymen opposed him and the way he organized his churches. Patrick preached in Ireland for the rest of his life.

**His writings** serve as the most important sources of information about Patrick's life and work. He wrote *Confession,* an account of his spiritual development, to justify his mission to Ireland and to express his humility and thankfulness that God called him to serve the Irish. Patrick also wrote *Letter to Coroticus.* In this letter, he criticized a raid on Ireland conducted by Coroticus, a British chieftain. Several of Patrick's converts were killed during the raid. The letter also shows Patrick's resentment of the scornful attitude of British clergymen and nobility toward the Irish.

**Legends about Patrick.** Many stories about Patrick are based only on legend. One of the best-known tales tells how he charmed the snakes of Ireland into the sea so they were drowned. According to another legend, Patrick used a three-leaf shamrock to illustrate the idea of the Trinity. Many people believe the shamrock came to be the traditional symbol of Ireland as a result of this legend. Today, Irish Catholics throughout the world celebrate Saint Patrick's Day on his feast day, March 17 (see Saint Patrick's Day).

See also **Ireland** (Saint Patrick).

**Patriotism** is the love and loyal support of one's country. It includes attachment to a country's land and people, admiration for its customs and traditions, pride in its history, and devotion to its welfare. The term suggests a feeling of oneness with the nation.

Patriotism has existed in all ages and among all peoples. Evidence of this universal feeling can be found in the literature of many countries. Many outstanding literary works praise loyalty to one's country and willingness to suffer death in defence of a country's freedom and good name. In wartime, patriotic songs and slogans have helped unite citizens in support of their country.

Schools help develop patriotism in order to create an appreciation of common memories, hopes, and traditions. Through the study of history, for example, many students learn to love their country and admire its great heroes. Patriotic organizations maintain and promote such symbols of patriotism and national glory as the national flag, and national shrines and monuments.

While most people agree that patriotism involves serving one's country, many disagree on how they can best perform such service. Some say that the national government speaks for the country, and that citizens should therefore actively support all government policies and actions. Others argue that a true patriot will speak out if convinced that the country is following an unjust or unwise course of action.

**Development of patriotism.** The word *patriotism* comes from the Greek word *patris,* which means *fatherland.* Throughout most of history, love of fatherland or homeland was a simple idea with no special political involvement. It was a love for the physical features of the land, including mountains, plains, and rivers.

The idea of patriotism became more complicated after new means of transportation and communication developed. In the 1800's, for example, the railway and the steamship permitted large numbers of people to move long distances more quickly and easily than ever before. As a result, people were less likely to remain in


**Patriotism** has existed in all ages and among all peoples. The poster *above* appealed to patriotism. It was used to encourage recruitment for the British armed forces during World War I (1914-1918).

the hometowns or countries of their forefathers throughout their lives. New means of communication, such as the telegraph, kept people informed of happenings far away from their communities. The development of tanks and other weapons enabled nations to gain control over greater areas of land than ever before.

These developments raised some basic questions about patriotism and loyalty. Some people asked whether they were to love the land of their ancestors, the land of their birth, or the country in which they were presently living. Others asked how patriotism could mean love of country when most people had never seen most of the territory in it.

Some answers to these questions were provided by two political forces that were taking shape—*democracy* and *nationalism.* The democratic ideal was that people should have the right to govern themselves. One of the ideals of nationalism was that the people who share a common language, culture, and tradition should form one nation with their own independent government. Patriotism became entangled with these new forces. Along with love of one's own region, or country, patriotism came to mean supreme loyalty to the nation. Patriots were expected to willingly give their lives, if necessary, to defend the nation. See **Democracy; Nationalism.**

**Abuses of patriotism.** "Patriotism," wrote the English critic Samuel Johnson, "is the last refuge of a scoundrel." He was pointing out that patriotism, like other emotional attitudes, sometimes becomes exaggerated or distorted. People with an excessive attachment for a certain group

or country are sometimes called *superpatriots*. An unreasoning enthusiasm for the military superiority and glory of one's country is often called *chauvinism* or *jingoism* (see **Jingoism**).

Exaggerated or distorted forms of patriotism have existed at different times in almost all nations. In the late 1800's, the French and English believed they had a moral responsibility to establish colonies in Asia and Africa, and thus bring the benefits of their culture to their "inferior brothers." In the 1900's, the Germans under Adolf Hitler and the Italians under Benito Mussolini became convinced their nations had a patriotic mission to extend their territorial boundaries.

Demands for public demonstration of loyalty are often heard in times of national crisis. During World War I, for example, King George V of the United Kingdom (UK) changed the name of the royal family from the German Saxe-Coburg to Windsor because the UK was at war with Germany. During World War II, thousands of patriotic Japanese-Americans were placed in detention camps because of unreasonable fears that they might be loyal to Japan rather than to the United States.

**Patroclus.** See **Iliad**.

**Patron saints** are saints chosen to protect the interests of a country, place, group, or activity, and to intercede for them in heaven (see **Saint**). For example, St. George is the patron saint of England; St. Andrew, of Scotland; St. David, of Wales; and St. Patrick, of Ireland. St. Cecilia is the patron saint of music.

**Patten, Christopher Francis** (1944- ), became governor of Hong Kong in 1992. During his five-year term of office, he is responsible for the transfer of Hong Kong from British control to Chinese rule. China leased Hong Kong to the British in 1898 for a period of 99 years (see **Hong Kong**).

Chris Patten is a British Conservative politician, who became member of Parliament for Bath in 1979. From 1979 to 1985 he held junior government posts. He wrote a study of Conservatism, *The Tory Case* (1983). In 1985, Patten became minister of state for education and science, and in 1986 was appointed minister of overseas development at the Foreign and Commonwealth Office. He became secretary of state for the environment in 1989 and chairman of the Conservative Party the following year. Patten led the party's campaign in the 1992 general election. The party was reelected to government, but Patten lost his parliamentary seat.

**Pattern.** See **Cast and casting; Design; Sewing.**

**Patterson, P. J.** (1935- ), became prime minister of Jamaica in March 1992. He took over from Michael Manley, who had resigned for health reasons. The People's National Party (PNP) elected Patterson to replace Manley as party leader. The PNP won the March 1993 general election, and Patterson remained party leader and prime minister.

Percival Noel James Patterson was born in the parish of Hanover. He graduated from the University of the West Indies in 1958. He studied law at the London School of Economics, graduating in 1963. In 1970, he entered the House of Representatives. He was vice president of the PNP from 1969 to 1982, and he served as the party's chairman from 1983 until he took over as PNP president in 1992.

See also **Jamaica**.

**Patton, George Smith, Jr.** (1885-1945), was one of the most colourful American generals of World War II (1939-1945). His toughness and rough speech earned him the nickname "Old Blood and Guts."

**African invasion.** In November 1942, Patton led the Western Task Force ashore in Morocco in the Allied invasion of North Africa. In March 1943, he took command of the Second U.S. Army Corps and won one of the first major U.S. victories of the war at El Guettar. Before the Tunisian campaign ended, Patton took command of the Seventh Army for the invasion of Sicily in July 1943. In 39 days, his army and the British Eighth Army captured the island.


George S. Patton, Jr.

**Victory in France.** In January 1944, Patton became commander of the Third Army for the French campaign. When the First Army broke through at St. Lô, Patton's forces poured through in the first of an amazing series of advances. They went so far ahead of their supplies that they had to be provisioned by plane. His forces crossed France, reaching Metz by autumn, and fought in the Battle of the Bulge near Bastogne, Belgium, in December 1944.

As Germany collapsed, the Third Army drove across southwestern Germany into Czechoslovakia and Austria. When the Germans surrendered, Patton's army held a large part of what became the American occupation zone. Patton became a full general. After May 1945, he took command of the occupation troops in the American zone. Eisenhower transferred him to the command of the Fifteenth Army, a headquarters set up to interview captured German generals and prepare materials for the official history of the war. In December 1945, Patton died of injuries from a car accident. He was buried in a Third Army cemetery in Luxembourg.

**Early life.** Patton was born on Nov. 11, 1885, in San Gabriel, California, U.S.A. He graduated from the U.S. Military Academy in 1909. An excellent athlete, he was placed fifth in the 1912 Olympic pentathlon. Patton entered the cavalry after graduation, and served in the 1916 Mexican expedition. In World War I (1914-1918), he commanded a tank brigade in France.

**Paul I** (1901-1964) was king of Greece from 1947 to 1964. He succeeded his brother, George II, as king during a civil war between Greek Communists and people who supported the monarchy. With his wife, Queen Frederika, Paul tried to make the Greek monarchy a protector of democracy and a supporter of all classes of Greek society. From 1917 to 1920, Paul lived in exile with his father, King Constantine I. From 1923 to 1935 and from 1941 to 1946, he lived in exile again, this time with George II. Paul was born in Athens, and was trained as a naval officer.

See also **Constantine II; George II** (of Greece).

**Paul III** (1468-1549) was elected pope in 1534 and reigned during the transition in Rome from the Renaissance to the church renewal movement called the Counter Reformation. While in many respects a Renais-

sance prince, Paul devoted serious attention to religious matters and helped further church reform. He named prominent theologians and churchmen to the college of cardinals, and he encouraged the development of new religious orders, notably the Society of Jesus, commonly called the Jesuits. In 1545, he convened the Council of Trent, which played a major role in the Counter Reformation (see **Trent, Council of**).

Paul was born in Canino, near Viterbo, Italy. His given and family name was Alessandro Farnese. Like many other Renaissance popes, he promoted the interests of his powerful family. He was an important patron of the arts, commissioning the completion of the elegant Farnese Palace and Michelangelo's painting *The Last Judgment* in the Sistine Chapel.

See also **Pope** (Renaissance and Reformation).

**Paul IV** (1476-1559) was elected pope in 1555. He reflected the most repressive tendencies of the church renewal movement called the Counter Reformation. Paul was harsh and intolerant and rejected any reconciliation with Protestantism during the Reformation. He denounced the religious settlement of the Peace of Augsburg (1555) for recognizing Lutheranism in Germany. Paul viewed any deviation from rigid orthodoxy with suspicion. He greatly extended the activities of the Inquisition, and the first Index of Forbidden Books was given official status in 1557. See **Inquisition; Index Librorum Prohibitorum**.

Paul was born near Benevento, Italy. His full name was Gian Pietro Carafa. He was personally ascetic and in 1524 he helped found the Theatines, a monastic order dedicated to a life of poverty and to church reform. Paul became a cardinal in 1536 and led the church reform party in Rome. Beginning in 1550, he headed the Roman Inquisition, gaining a reputation for unyielding severity.

See also **Ghetto**.

**Paul VI** (1897-1978) was elected pope of the Roman Catholic Church in 1963. He immediately pledged to continue Vatican Council II, called by John XXIII, the previous pope. Paul presided over the council, which ended in 1965 and which brought widespread reforms to the church. See **Vatican Council II**.

In 1964, Paul travelled to Jerusalem, where he met the ecumenical patriarch of Constantinople, Athenagoras I. The Eastern Orthodox Churches give the highest honour to this official. At the close of the Vatican Council, the two leaders issued a joint statement removing the excommunications issued by the Eastern and Western churches against each other in 1054. In 1965, Paul flew to New York City—the first papal visit to the United States—to plead to the United Nations for world peace.

Paul wrote several *encyclicals* (pastoral letters). They dealt mainly with dialogue among Catholics, non-Catholics, and non-Christians and with the need for social justice within nations and between richer and poorer nations. But Paul is perhaps best remembered for *Humanae Vitae (On Human Life)*, issued in 1968. This encyclical upheld the church's traditional prohibition against artificial means of birth control.

During his reign, Paul was often criticized as an extreme conservative. Today, many church historians consider him far more moderate than his critics recognized. After Vatican Council II, Paul had to skilfully steer the church on a middle course between liberals and conservatives. The liberals wanted to reform the church further than Paul thought was possible, while the conservatives rejected the council's reforms altogether.

Paul was born in Concesio, near Brescia, Italy. His full name was Giovanni Battista Montini. He was ordained a priest in 1920. After graduate studies in Rome, Paul served in the papal secretariat of state, with only a brief interruption, from 1922 to 1954. In 1954, he was appointed archbishop of Milan. John XXIII made him a cardinal in 1958.

**Paul, Saint,** was one of the most important leaders of early Christianity. He became famous as a missionary and a founder of congregations throughout Asia Minor and southeastern Europe. His letters, called *epistles,* to his followers form a significant part of the New Testament. Because of his importance, Paul is sometimes referred to as an "apostle," though he was not one of the 12 apostles of Jesus Christ.

**Early life.** Paul, a Jew by birth, was born a few years after the birth of Jesus. Paul was born in Tarsus, a city in Cilicia (now part of Turkey). His original name was Saul. He grew up exposed to both his family's Jewish religious heritage and the non-Jewish culture around him. As a youth, Paul went to Jerusalem and studied under the famous rabbi Gamaliel. At this time, Paul believed deeply in Judaism.

In Jerusalem, Paul met Jews who had become Christians. They believed that Jesus, who had been crucified, was the *Messiah,* the promised saviour of the Jews. Paul began to persecute these Jews because their beliefs and behaviour offended him. But one day, while travelling to Damascus, Paul was struck by a blinding light and he heard the voice of Jesus. Soon afterward, he began to preach that Jesus was the Son of God.

**Missionary career.** Paul's work in bringing Christianity to *gentiles* (non-Jews) shows his tremendous energy and dedication. He is often called the "Apostle to the Gentiles." Immediately after Paul's conversion, he went to an area of Arabia that is now in Jordan, and then to Syria and Cilicia. Historians know little about Paul's life as a missionary during the next 15 years.

The most productive period of Paul's career began shortly before A.D. 50. The Acts, a book of the New Testament, describes Paul's three journeys as a missionary during this period. On his first journey, Paul sailed to the island of Cyprus with two of his followers, Barnabas and Mark. He and Barnabas then crossed to the southern coast of Asia Minor. The story of this journey describes Paul's technique as a missionary. He moved quickly from place to place, preaching first in synagogues and then to gentiles. He gave bold, controversial speeches that angered many people. As a result, Paul was frequently mistreated and occasionally imprisoned.

Two other followers, Silas and Timothy, accompanied Paul on his second missionary journey. On this trip, Paul travelled to northwest Asia Minor. He then crossed to Macedonia, thus bringing Christianity to Europe. Later on this journey, Paul visited such Greek cities as Thessalonica and Corinth. Paul's third missionary journey covered much of the same territory as his second trip.

**Later years.** After Paul returned to Jerusalem, he was arrested because of opposition from hostile Jews. He spent two years in prison and then demanded his right as a Roman citizen to have a trial in the emperor's court.


**Saint Paul** made three important missionary journeys during the late A.D. 40's and 50's. He preached in Asia Minor and brought Christianity to Macedonia and Greece. On a fourth trip, he was sent as a prisoner to be tried in Rome.

First journey
Second journey
Third journey
Journey to Rome

0 400 Miles
0 400Kilometres

Paul was sent to Rome, where he remained a prisoner for two more years. He apparently died in Rome sometime after A.D. 60.

**Paul's letters and ideas.** The letters written by Paul helped him keep in touch with his followers. These letters date from a period between A.D. 50 and 60 and are the earliest books of the New Testament. Paul wrote Romans, First and Second Corinthians, Galatians, Philippians, First and Second Thessalonians, and Philemon. He probably also wrote Colossians and may have written Ephesians, First and Second Timothy, and Titus. The Epistle to the Hebrews, once credited to Paul, is now considered the work of another writer.

Paul viewed Christianity primarily in relation to Judaism. He felt that the history of the Jews and the writings of the Old Testament had prepared humanity for Christianity. Nevertheless, Paul regarded the Christian faith—or "life in Christ," as he called it—as something new. In Judaism, God and human beings were related chiefly through the *Torah,* the first five books of the Old Testament. The Torah expressed God's will and informed people of their responsibilities to Him.

Paul believed the death and Resurrection of Jesus opened a new kind of relationship between God and human beings. He was certain that gentiles, who did not know the Torah, could benefit from this new relationship, called *justification.* Justification resulted not from something that human beings did, such as obey the Torah, but from something God had done. In Jesus, God had given humanity a gift. Paul felt that this gift put God and people into their proper relationship, which human effort alone never could have done. To Paul, justification was the heart of Christianity.

By means of his letters, Paul encouraged early Christians in times of discouragement and persecution. He reminded his followers of their responsibilities to one another and thus provided many basic ideas of Christianity. Christians recognized Paul's importance by preserving his letters and making them a central part of the New Testament.

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Romans, Epistle to the
Thessalonians, Epistles to the
Timothy
Titus

**Paul, Saint Vincent de.** See Sisters of Charity.

**Paul Bunyan.** See Bunyan, Paul.

**Paul of the Cross, Saint** (1694-1775), founded the Passionist Order, or the Congregation of the Discalced Clerks of the Most Holy Cross and Passion of Our Lord Jesus Christ. Paul, an Italian priest, had a vision urging him to establish a new religious order, and in 1720 he founded the Passionists. The order grew rapidly and now works throughout the world. The Passionists practise strict poverty. Paul was born in Oveda, Italy. He was *canonized* (proclaimed a saint) in 1867 by Pope Pius IX.

**Pauli, Wolfgang** (1900-1958), an Austrian theoretical physicist, won the 1945 Nobel Prize in physics for his proposal in 1925 of a rule explaining the behaviour of electrons in atoms. Such electrons orbit the nucleus of the atom. The rule, now called the *Pauli exclusion principle,* holds that no two electrons in an atom can have the same *quantum numbers.* An electron in an atom has four such numbers. They define the energy of the electron in terms of the distance of its orbit from the nucleus, the orbit's shape, the orientation of the axis of the orbit, and the electron's spin on its own axis.

Pauli's principle was a key new idea. In 1913, Danish physicist Niels Bohr had published a theory describing how the single electron of the hydrogen atom moves around the nucleus. Pauli's discovery enabled scientists to picture the atomic structure and the behaviour of the electrons of every known chemical element (see Atom). Because the behaviour of an atom's electrons determines how that atom will take part in chemical reactions, the principle also explained the chemical characteristics of the elements.

Pauli also explained the loss of energy and *angular momentum* (a measurement of spin) in certain atom-smashing experiments. In 1930, he proposed the existence of a subatomic particle, now called a *neutrino,* that has the "missing" energy and momentum. See Neutrino.

Pauli was born in Vienna, Austria. In 1928, he became professor of theoretical physics at the Federal Institute of Technology in Zurich, Switzerland.

**Pauline Letters.** See Bible (Books of the New Testament).

**Pauling, Linus Carl** (1901-1994), an American chemist, won two Nobel Prizes. He received the 1954 Nobel Prize for chemistry and the 1962 Nobel Peace Prize.

Pauling won the chemistry prize for his research on the nature of chemical bonds. He showed that a knowledge of the way atoms are linked helps explain the

structure of complex molecules. Pauling began his research by studying the structure of crystals. He analysed the way atoms in a crystal *diffract* (spread out) X rays as the rays pass through the crystal. Pauling combined his findings with the theories of *quantum mechanics* about the arrangement of electrons within an atom and the ways in which atoms share and exchange electrons (see **Quantum mechanics**). In this way, he calculated the energies that bind atoms, the distances between the atoms, and the angles at which the bonds between atoms form.

Much of Pauling's research involved the study of *amino acids,* the organic compounds that make up proteins. His work contributed greatly to an understanding of the complex molecular structure of proteins. It also led to new knowledge about *sickle cell anaemia,* a disease of the red blood cells. Pauling later attracted attention for his experiments on the use of vitamin C in treating cancer and the common cold.

Pauling won the Nobel Peace Prize for his efforts to ban nuclear weapons, especially his campaign against nuclear weapons testing. In 1958, he submitted a petition to the United Nations (UN) that stated in part: "Each added amount of radiation causes damage to the health of human beings all over the world." More than 11,000 scientists from 49 countries signed the petition. It helped lead to the signing of a treaty in 1963 that outlawed nuclear tests in the atmosphere, in outer space, and underwater—but not underground. The treaty was signed by the United States, the Soviet Union, the United Kingdom, and most other UN members.

Pauling was born in Portland, Oregon, U.S.A. He received a Ph.D. degree from the California Institute of Technology in 1925.

**Paulists** are members of the first Roman Catholic order of priests to be founded in America. Isaac Thomas Hecker, an American priest, founded the order in New York City in 1858. Its full name is the Society of Missionary Priests of St. Paul the Apostle. Hecker founded the Paulists as a community of priests dedicated to Americanizing immigrant Roman Catholics and carrying Catholicism to non-Catholic Americans. Today there are only about 250 Paulists in the United States, Canada, and Rome. Despite their small numbers, the Paulists have been influential, especially through their effective use of print media, radio, and television.

**Pavarotti, Luciano** (1935- ), an Italian lyric tenor, became one of the most popular opera stars of the 1900's. He won fame for the warmth and flexibility of his voice, the security of his high notes, and the intense feeling in his singing.

Pavarotti has concentrated mostly on Italian operas and songs. He won fame for his performances in such roles as Rodolfo in *La Bohème,* Edgardo in *Lucia di Lammermoor,* and the Duke of Mantua in *Rigoletto.* In the late 1970's, Pavarotti began to perform more dramatic roles, including Mario in *Tosca* and Manrico in *Il Trovatore.*

Luciano Pavarotti was born in Modena, Italy. He made his professional debut in Reggio nell' Emilia, Italy, in 1961 as Rodolfo.

See also **Opera** (picture: *La Bohème*).

**Luciano Pavarotti,** an Italian lyric tenor, is one of the world's most popular concert and opera singers.

**Pavlov, Ivan Petrovich** (1849-1936), a Russian physiologist, won the 1904 Nobel Prize for physiology or medicine for his research on digestion. He showed how the *vagus nerve* controls the flow of digestive juices of the stomach and pancreas.

For the next 30 years, Pavlov studied the functions of the brain. He found that, by repeated association, an artificial stimulus (such as a bell) could be substituted for a natural stimulus (food) to cause a physiological reaction (salivation). He called this a *conditioned reflex.* In his most famous experiment, he trained a dog to react in this way. Pavlov believed that all acquired habits, and even higher mental activity in humans, depend on chains of conditioned reflexes (see **Reflex action**). Pavlov was born in Ryazan, Russia. He was educated in Russia and Germany.

See also **Behaviour** (Behaviourism); **Nobel Prizes** (picture: Ivan Petrovich Pavlov).

**Pavlova** is a meringue dessert topped with whipped cream. It resembles a *tutu* (ballet skirt) and was created in honour of the Russian ballerina Anna Pavlova. The origin of the dessert is disputed. In New Zealand, where it is claimed to be the country's first and only contribution to international cuisine, it is said to have been invented by a woman during or shortly after Pavlova's visit there in 1926. But an Australian chef, Herbert Sachse, claimed to have invented it in 1935.

**Pavlova, Anna** (1881-1931), a Russian ballerina, became the most famous dancer of her generation. Anna Pavlova was a small, delicate woman whose style of dancing was lovely and graceful. She was best known for "The Dying Swan," a three-minute solo created for her by the Russian choreographer Michel Fokine.

Anna Pavlova was born in St. Petersburg. She graduated from the Imperial Ballet School in 1899 and joined the Imperial Ballet Company. In 1906, she became prima ballerina of the company. In 1909, she travelled to Paris to join Sergei Diaghilev's dance company, the *Ballets Russes.* Pavlova left Russia permanently in 1914 and settled in London. During World War I (1914-1918) she formed her own company and took it on world tours

**Anna Pavlova, Russian ballerina,** performed with a lightness and grace that few ballet dancers have ever attained.

from that time until her death in The Hague, in the Netherlands.

See also **Ballet** (picture).

**Pawnbroker** is a person who lends small sums of money on watches, jewellery, musical instruments, and other belongings that are left with the pawnbroker as security. The articles that are left are *pawned.* The pawnbroker has the right to sell these articles if the loan is not repaid with interest and charges within a certain time after the debt becomes due.

The pawnbroker usually limits the loan to a fraction of the value of the article, which provides security for the loan. For this reason, pawnshop customers do not usually regard the transaction as a sale of their goods. Customers pay back the loan with interest to redeem their property. The pawnbroker makes it possible for a person with short term cash needs to obtain credit quickly, even in a strange city.

Pawnshops began to disappear from many areas due to the widespread availability of credit cards, which provided easy access to small loans at lower interest rates. There has been a reemergence of pawnshops however, resulting from creditcard debt.

Pawnbroking dates back to the time when there were no banks. It was known in ancient China and became accepted in Europe in medieval times. Modern legislation relating to pawnbrokers was introduced in many countries in the 1800's. The earliest laws were made to prevent the charging of high interest rates.

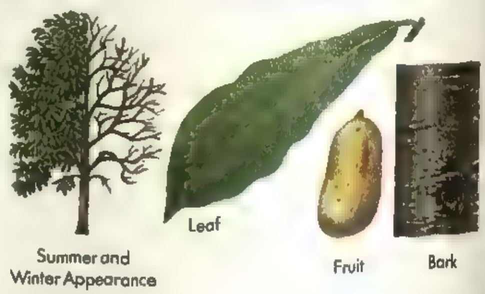
Pawnbroking policy varies from country to country. In general, regulations require the pawnbroker to keep a record book. It contains a description of every article received. This book must be submitted upon request to the police or other authorities who may be looking for stolen goods. The pawnbroker is not allowed to receive goods from anyone under a specified age.

Three golden balls, an old trade sign of the pawnbroker, usually hang outside the pawnshop. They originated with the moneylenders of Lombardy in Italy, who were important bankers in medieval England. The three golden balls were also the coat of arms of the Medicis, a family of merchants and moneylenders of Florence.

**Pawpaw** is a small tree or shrub native to North America. The tree produces a fruit, also called *pawpaw,* that looks somewhat like a thick, short banana. The plant is found in the southern United States, and as far north as Kansas, Michigan, New Jersey, and western New York. Its leaves spread out in umbrellalike whorls, as do those of some species of the magnolia. However, when the leaves are bruised they give off a disagreeable odour.

The pawpaw grows to between 3 and 12 metres high, and bears fruit 5 to 15 centimetres long. The fruit has a greenish-brown skin. The yellow pulp is soft and sweet, but does not have enough taste to make it popular as a table fruit. The wood of the tree is too soft and coarse to be valuable. The thin fibrous bark may be used in making fishing nets.

Another tree called *pawpaw, papaw,* or *papaya,* is grown in the tropics for its edible fruit. In Florida, U.S.A. it is cultivated for the local market. See **Papaya.**




**The pawpaw tree is native to North America.**

**Scientific classification.** The American pawpaw belongs to the custard apple family, Annonaceae. It is *Asimina triloba.* The tropical species belongs to the pawpaw family, Caricaceae.

**Pax Romana.** See **Rome, Ancient** (History: The height of the empire).

**Paxton, Sir Joseph** (1801-1865), a British architect and landscape gardener, designed the Crystal Palace. His design was for a building at the Great Exhibition of 1851, in Hyde Park, London. This building was later taken down and re-erected at Sydenham, in south London, as the Crystal Palace. Paxton was born at Milton Bryant, in Bedfordshire, England.

See also **Crystal Palace.**

**Payback** is the name given to revenge killing practised in New Guinea. If one man fought another, or two tribes fought, then, at a later date, relatives of the dead would kill someone from the killer's family. Between 1954 and 1967, 70 payback killers appeared in New Guinea courts. Today, the government of Papua New Guinea has special powers to punish different groups for fighting.

**Payne, John Howard** (1791-1852), was the first American playwright to achieve international fame. However, he is best known for writing the words of the song "Home, Sweet Home." This song first appeared in his play *Clari, or the Maid of Milan* (1823).

Payne was born in New York City. His first play, *Julia, the Wanderer* (1806), was performed there when he was only 14 years old. At 17, Payne made his debut as an actor. He went to London in 1813 and lived there and in Paris until 1832. In London, Payne tried to establish himself as an actor but failed. He soon turned to playwriting.

Many of Payne's plays were unsuccessful, and he spent most of his life in debt. But he did achieve some popularity with his tragedy *Brutus, or the Fall of Tarquin* (1818) and other dramas. In 1823, while in London, Payne worked with the American writer Washington Irving on *Charles the Second, or The Merry Monarch* and several other productions.

Payne returned to the United States in 1832 and later became interested in the problems of American Indians. In 1835, he met leaders of the Cherokee Indians and published two letters in the *Knoxville* (Tennessee) *Register.* In them, he tried to persuade the U.S. Congress to let the Cherokee continue living in the Southeast. His efforts failed. Payne served as U.S. consul in Tunisia from 1842 to 1845 and from 1851 until his death.

**Payton, Walter** (1954- ), a running back for the Chicago Bears American football team, became the leading rusher in National Football League (NFL) history. In 1984, Payton broke Jim Brown's 12,312-yard (11,258-metre) career rushing record. He retired after the 1987 season with a career rushing total of 16,726 yards (15,294 metres). On Nov. 20, 1977, he set the NFL single-game rushing record of 275 yards (252 metres) against the Minnesota Vikings. Payton stands 1.8 metres tall and weighs about 90 kilograms. He gained acclaim from enthusiasts as a strong, durable, versatile runner and pass receiver.

**Walter Payton** became the leading rusher in NFL history in 1984. He broke Jim Brown's 12,312-yard career rushing record.

Walter Jerry Payton was born in Columbia, Mississippi, U.S.A. He was a star running back at Jackson State University. Payton was selected by Chicago in the first round of the 1975 college player draft and spent his entire NFL career with Chicago.

**Paz, Octavio** (1914- ), a Mexican poet and essayist, won the 1990 Nobel Prize for literature. He was the first Mexican author to receive the prize. Paz's works reflect a range of influences, including Aztec mythology, Marxism, Oriental philosophy, surrealism, and symbolism.

Paz's collection, *Liberty Under Oath* (1960), consists of poems written between 1935 and 1957. *The Collected Poems of Octavio Paz, 1957-1987* (1987) includes his well-known "Sunstone." This poem uses contrasting images to symbolize the inevitable loneliness of individuals and their search for union with others.

Paz has written essays on many subjects, including anthropology, literature, philosophy, and science. *The Labyrinth of Solitude* (1950) is a collection of essays that deal with the character of the Mexican people. In "The New Mexico" (1970), Paz analyses civilization, language, and political protest. *El Mono Gramático* (1972) combines essay, narration, and poetry to present his thoughts on life and art. His reflections on modern history appear in *One Earth, Four or Five Worlds* (1985).

Paz was born in Mexico City. From 1962 to 1968, he served as Mexico's ambassador to India.

**PCB.** See **Polychlorinated biphenyl.**

**PDSA** is the United Kingdom's largest animal charity, with two overseas branches in South Africa and Cairo. Its full name is the People's Dispensary for Sick Animals. It provides free medical treatment for sick animals and is funded entirely by voluntary contributions.

In the United Kingdom, the PDSA's permanent and mobile dispensaries give free treatment to thousands of domestic pets each year. They also advise pet owners on animal care. The PDSA has several animal ambulances that transport sick animals to its Veterinary Centres. These are located in most major cities. The PDSA's overseas units provide care and treatment for working animals and domestic pets in disadvantaged communities. The PDSA operates two junior sections to educate children in animal care. It also publishes magazines and petcare booklets for its junior and adult sections.

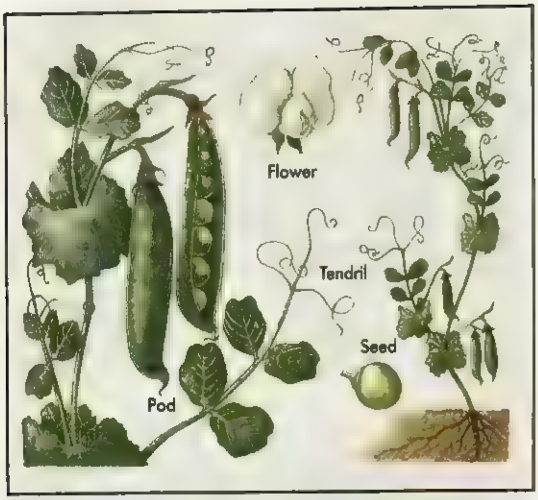
Maria Elizabeth Dickin founded the PDSA in east London in 1917.

**Pea** is a plant grown chiefly for its round edible seeds, which are also called peas. Cooked peas are a popular food in many countries. People also add peas to soups, salads, casseroles, and other dishes. Peas are also used as feed for livestock. Peas are a good source of protein and vitamins A and C.

Pea plants have vines with soft stems that measure up to about 185 centimetres long. Each leaf consists of one to three pairs of leaflets, and it ends in a curly thread called a *tendril.* Most pea plants have white flowers. Some have reddish-purple blossoms. Pea plants bear pods that contain four to nine or more seeds.

Peas belong to a large family of plants called *legumes,* which produce pods. Other legumes include beans, peanuts, and alfalfa. See **Legume.**

**Kinds of peas.** There are two main types of peas, *field peas* and *garden peas.* Field peas have smooth, hard seeds that may be green, yellow, white, grey, blue,




**Pea plants** are grown chiefly for their seeds, which are also called peas. Garden peas, *left,* have sweet, soft seeds. Field peas, *right,* have smooth, hard seeds.

brown, or spotted. Some varieties of yellow and green field peas are marketed as *split peas* for making soup. Other varieties are used as fresh pasture for livestock, or are made into hay or silage. Garden peas generally have green, wrinkled seeds, though some varieties have smooth seeds. Garden peas are sweeter and softer than field peas and are popular with home gardeners. Varieties known as edible-podded peas are eaten with the pods and are often used in Oriental cooking. A French variety called *mangetout* (eat all) is growing in popularity in Western cooking.

**Growing peas.** The pea plant is an *annual*—that is, it must be replanted each year. Peas require rich soil, constant moisture, and a cool growing season to develop well. Peas are planted in early spring and are harvested 60 to 70 days later.

Field peas are usually planted by a *grain drill,* a machine that drops the seeds and covers them with soil. They are harvested with a mowing machine or a combine harvester. Garden peas are usually planted and harvested by hand. They are planted 2.5 to 5 centimetres deep in rows 50 to 75 centimetres apart.

**Diseases and pests.** The most common diseases of pea plants are *leaf spot, stem blight, bacterial blight,* and *fusarium wilt.* Leaf spot, stem blight, and bacterial blight produce spots on the plants. Fusarium wilt restricts the growth of pea plants and makes them yellow. Scientists have developed varieties of peas that can resist these diseases. Leaf spot, stem blight, and bacterial blight can also be controlled with pesticides.

Pea plants are also attacked by such insect pests as *pea weevils, pea moths,* and *pea aphids.* Pea weevils and pea moths produce young that burrow into the pods and eat the seeds. Pea aphids damage a plant by sucking its juices and spreading virus diseases. Farmers control most of these pests with insecticides.

**Scientific classification.** Peas belong to the pea family, Leguminosae (Fabaceae). Garden peas are *Pisum sativum.* Field peas are *P. arvense.*

See also **Cowpea**.

**Peace** is the state of being calm, quiet, and free of disturbance. From a military and political point of view, peace means freedom from such violent disturbances as wars and riots. It does not mean total harmony among people. Even in peacetime, people take part in such forms of conflict as debates, lawsuits, sports contests, and election campaigns.

Throughout history, most people have wanted lasting peace. Religions and philosophers have called for the peaceful settlement of disagreements. The Bible declares, "Thou shalt not kill" and "Blessed are the peacemakers." Philosophers in ancient Greece and Rome taught brotherhood and nonviolence.

Yet since earliest times, the world has seldom had a long period of unbroken peace. Through the centuries, people have probably spent at least as much time at war as at peace. This article discusses past and present attempts to achieve lasting freedom from war.

### Peacemaking efforts through the years

**Ancient Greece and Rome.** Ancient Greece consisted of many independent regions called *city-states.* The city-states frequently waged war on one another. As a result, several of them banded together and formed an organization that made one of the first attempts to limit warfare. This organization, called the Amphictyonic League, prohibited any member from destroying another or cutting off another's water supply.

Once every four years, the Olympic Games united the city-states. A truce created temporary peace throughout Greece so the games could take place. For a month, no one could bear arms or make war.

The Roman Empire maintained peace throughout a large part of the world during a period known as the *Pax Romana* (Roman peace). This peace lasted more than 200 years, from 27 B.C. to A.D. 180. During the Pax Romana, the Roman Empire extended over much of Europe, the Middle East, and northern Africa. At that time, no other nation had sufficient military power to attack the Romans.

**The Middle Ages.** After the Roman Empire weakened during the A.D. 400's, small wars raged throughout Europe. The Christian church became the greatest force for peace. A church custom called the Truce of God limited fighting in private disputes to certain days of the week. Another ruling, known as the Peace of God, forbade fighting in such holy places as churches and shrines. But the church permitted so-called "just" wars, such as those in defence of Christianity or a people's homeland.

**From the 1400's to the 1700's,** many people proposed various plans to achieve lasting peace. In the early 1600's, for example, the French statesman Maximilien de Béthune, Duke of Sully, developed a "Grand Design" for peace in Europe. Sully's plan called for the formation of a council of representatives of all European countries. The council would settle disagreements between nations.

In 1625, the Dutch statesman Hugo Grotius proposed international rules of conduct in a book called *On the Law of War and Peace.* For example, nations should guarantee certain rights to neutral nations, which took no part in a war. Grotius' ideas formed the basis of international law (see **International law**).

The Thirty Years' War ended in 1648 with the Peace of Westphalia. This treaty tried to ensure peace by establishing a *balance of power.* Such a plan maintains an even distribution of military and economic power among nations. As a result, no nation or group of nations is strong enough to conquer any other nation or group of nations. See **Balance of power.**

About 1647, the English religious leader George Fox founded the Society of Friends, most commonly known today as the Quakers. This group believed that the teachings of Jesus Christ prohibited war. Throughout their history, the Quakers have opposed war and supported peace movements. The Quaker leader William Penn, who founded the American colony of Pennsylvania, proposed a peace plan similar to Sully's "Grand Design." Penn wrote a book called *An Essay Towards the Present and Future Peace of Europe* (1693). In it, he called for an international council to settle disputes between nations.

The *Project for Perpetual Peace,* written by a French clergyman, the Abbé Charles Irénée Castel de Saint-Pierre, was published in 1713. It called for a "Senate of Europe" composed of 24 delegates from the European nations. The French philosopher Voltaire criticized this plan because the member nations would have been monarchies. Voltaire believed the world could not have peace unless all nations became democracies.

**The 1800's and early 1900's.** In 1815, an American businessman, David Dodge, formed the New York Peace Society. Other *pacifist* groups followed, including the American Peace Society in 1828 and the Universal Peace Union in 1866.

During the 1800's, many international conventions discussed peacekeeping. Peace conferences met in London in 1843; in Brussels, Belgium, in 1848; in Paris in 1849; and in Frankfurt, Germany, in 1850. In 1898, Czar Nicholas II of Russia called for an international meeting to discuss arms limitation. As a result, conferences took place at The Hague in the Netherlands in 1899 and 1907. These two conferences did not succeed in limiting armaments. But they did establish the Permanent Court of Arbitration to handle legal disputes between nations.

The Swedish chemist Alfred Nobel, who invented dynamite, regretted the wartime death and injury caused by his invention. In his will, he set up a fund to award annual prizes, including one for outstanding work in promoting world peace. The first Nobel Peace Prize was awarded in 1901 (see **Nobel Prizes**).

After World War I ended in 1918, a group of 42 governments established the League of Nations. This international association had the goal of maintaining peace throughout the world. Disputes between nations would be settled by the League Council or by *arbitration,* a decision by a third party. But the League of Nations had little power, partly because the United States and some other major nations never joined.

### Current efforts to ensure peace

Since the end of World War II in 1945, many attempts have been made to assure lasting peace among all nations. The major forms of these efforts have included (1) diplomacy, (2) international organizations, (3) disarmament, (4) collective security, and (5) improvement of international communication and trade.

**Diplomacy** involves *negotiations* (discussions) between two or more nations. Most governments have diplomats who serve as their representatives in other countries to promote international cooperation and harmony. Other peace efforts depend largely on successful diplomacy. Many experts consider diplomacy to be the most important factor in peacekeeping between nations. See **Diplomacy.**

**International organizations** work for the peaceful settlement of disagreements between nations. In 1945, representatives of 50 countries created the United Nations (UN), the major international organization dedicated to world peace. The League of Nations was officially dissolved the next year.

The UN Security Council investigates quarrels between nations and suggests ways of settling them. If any nation endangers the peace, the council may use economic *sanctions* (penalties) against that country. For example, member nations might stop trading with the offender. If such measures do not work, the council may ask UN members to furnish troops to enforce its decision. The UN has achieved some success in keeping the peace. But it has been unable to prevent local wars in several regions, including Africa, Southeast Asia, and the Middle East.

**Disarmament** involves the control, reduction, or elimination of certain armed forces or weapons. In 1968, the UN approved a *nonproliferation treaty* to stop the spread of nuclear weapons. This treaty, which took effect in 1970, bars the nuclear powers from giving nuclear weapons or knowledge to other nations.

The UN also won approval of arms-control treaties during the 1970's. One treaty banned the production and stockpiling of biological weapons. The United States, Russia, and other nations have agreed to observe limits on the production and possession of nuclear weapons. In 1993, 125 countries signed a UN-sponsored treaty banning the manufacture, use, transfer, and stockpiling of chemical weapons. The treaty required ratification by 65 nations. See **Disarmament.**

**Collective security** resembles the balance of power system. Each member of a group of nations agrees to come to the aid of any other member if that nation is attacked. The combined strength of the group discourages enemy attacks. Such groups include the North Atlantic Treaty Organization (NATO).

**Improvement of international communication and trade** increases understanding among nations. It reduces the danger of war by lowering the cultural and economic barriers that divide countries. The European Community is a group of European nations committed to economic union and closer political integration. It has greatly improved the flow of goods, ideas, and people from nation to nation.

**Related articles** in ***World Book*** include:

Arbitration
Conscientious objector
Hague, The
International relations
Kellogg-Briand Peace Pact
League of Nations
Pacifism
United Nations
War (War aims and peace aims)

**Peace Corps** is an independent overseas volunteer programme of the United States government. Men and women in the Peace Corps work with people in developing countries to help them improve their living condi-

tions. The chief goals of the corps are (1) to help the poor obtain everyday needs, (2) to promote world peace, and (3) to increase understanding between Americans and the people of other nations.

**How the corps works.** The Peace Corps selects, trains, and supports American men and women for two years of service. The corps sends people into a country only at the request of that nation. Corps members are called *volunteers,* and the country in which they serve is called the *host country.* The corps consults the government of the host country in deciding what projects to undertake and what skills to seek when choosing volunteers.

Most projects are designed to raise the living standards of people who live in villages. The corps works to improve agriculture, health care, and education in the host country. It also promotes local leadership and local management of community resources and helps develop small businesses.

Volunteers serve in Africa, Asia, Eastern Europe, and Latin America and on various islands in the Pacific Ocean. They live and work with people of the host country. The most important part of their work consists of training the people to do the job that the volunteers are doing. For example, a Peace Corps carpenter may teach people construction skills as he or she works.

**Choosing volunteers.** To qualify for service in the Peace Corps, a person must be a United States citizen and at least 18 years old. The corps has no upper age limit. Married couples may volunteer. The Peace Corps seeks dedicated individuals who can learn skills and work effectively with people. Volunteers must be able to adapt to cultures and living conditions widely different from those in the United States.

Volunteers receive from 8 to 14 weeks of training. Most of them train in the host country, but some attend a Peace Corps training centre in the United States. Trainees study the culture, history, and language of the country in which they will serve. They also receive technical training for their specific assignments.

**History.** John F. Kennedy was elected President of the U.S.A. in November 1960, and he established the Peace Corps on March 1, 1961. The first volunteers started training at Rutgers University in New Brunswick, New Jersey, that same year.

More than 120,000 Americans have served as Peace Corps volunteers. In the early 1990's, about 6,100 men and women worked in 91 countries. The United States also supported the efforts of other nations to set up similar organizations.

**Service programmes in other countries.** Agencies similar to the Peace Corps have been set up by Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Israel, Japan, Korea, Liechtenstein, the Netherlands, New Zealand, Norway, the Philippines, Sweden, and the United Kingdom. These organizations vary in several ways, including name, size, and length of service. But all of them, like the Peace Corps, enlist volunteers from among their nation's citizens to serve in other countries.

See also **Latin America** (Latin America and the United States).

**Peace of . . .** See articles on peace agreements listed under their key word as in **Utrecht, Peace of.**

**Peace pipe,** also called *calumet,* was a ceremonial tobacco pipe that North American Indians smoked as a sign of peace and friendship. They passed it from one person to another. Among the Indians of the Great Lakes, Mississippi Valley, and Great Plains, this pipe had a stone bowl and a long wooden stem decorated with feathers. Early French explorers called the pipe and the dance held in its honour the *calumet,* from their word for the reed that sometimes formed the pipe's stem.

Most Indian pipes were not peace pipes. Indians of many tribes smoked solely for pleasure. Other pipes were used only in religious ceremonies.

**Peach** is a roundish, yellow to reddish, edible fruit. It has a hard, deeply pitted stone. Its flesh may be soft or quite firm. Among *deciduous* (leaf-shedding) tree fruit, only the apple and the pear are more widely distributed throughout the world than the peach. Peach trees grow in most temperate regions.

*Horticulturists* (plant scientists) believe that China is the native home of the peach. They believe the trees grew there at least 4,000 years ago. The peach was spread throughout Europe by the Romans. Spanish explorers took the peach to the Americas as early as the 1500's. Italy is the world's leading producer of peaches. Many peach trees are planted in commercial orchards, and some are cultivated in gardens as ornamental trees. California is probably the world's most famous peach producing region. It produces about two thirds of the peaches grown in the United States. In northern Europe most peach production is under glass.

Peach trees grow 4.5 to 7.5 metres high. Their slender leaves have toothed edges. Flowers appear before the leaves. The delicate pink blossoms may be large and showy, but sometimes are quite small. They appear early in the spring and can be injured by late frosts. Most commercial peach orchards are located in regions where there are few late frosts. Clear, hot weather during the growing season is best for peaches.

**Cultivars.** There are many *cultivars* (varieties produced by selective breeding) of peaches. They ripen from early summer to autumn—some as late as October in the northern hemisphere or March in the southern hemisphere. Peaches are called *freestone* or *clingstone,* according to how difficult it is to remove the pit from the fruit. The fruit of freestone peaches is usually softer than that of clingstones. But some cultivars of clingstones are very mellow, with fine aroma and excellent texture.

Perhaps the best-known peach cultivar is Elberta, a freestone. It originated in 1870 in Marshallville, Georgia, in the Southern United States. Nectarines are similar to peaches. The two fruits are essentially alike except for the skins, and the trees are identical (see **Nectarine**).

**Growing peach trees.** Most commercially important cultivars of peach are reproduced by attaching a bud of the desired cultivar to a rootstock from a different cultivar. This procedure is called *budding.* Rootstock cultivars are chosen on the basis of their ability to produce stronger or dwarf-type trees. One-year-old rootstocks are budded in late summer. The newly budded trees lie dormant until the next spring, when the buds are forced into growth. The age of a peach tree is determined by the age of the bud even though the rootstock is one year older.

The peach is a tasty fruit that has a hard, pitted stone, *above.* The fruits develop from the pink blossoms of the peach tree. The peaches that are to be sold as fresh fruit generally are picked by hand to avoid bruising, *below.*

*Cultivation.* Peach trees grow best on a deep, well-drained, medium-textured soil, such as a sandy loam. Growers plant standard-sized trees about 5.5 to 7.5 metres apart in the orchard. But those trees grown on dwarfing rootstocks are planted about 3.5 to 4.5 metres apart. A peach orchard begins to bear large crops about 3 or 4 years after it is planted. If the trees are healthy, they live about 20 years. They reach peak production when they are 8 to 12 years old. A single tree may produce about 90 to 220 kilograms of peaches each year.

Peach trees must be watered regularly. The amount of water required varies with climate, soil texture and depth, and depth of the root system. Enough water must be used to wet the entire root system. Cultivation of the orchard is necessary to destroy weeds, which compete with the trees for water and mineral nutrients in the soil. Chemical sprays are often used to control weeds.

Peach trees need various mineral nutrients for normal growth. Most of these occur in sufficient quantity in the soil. But usually nitrogen must be added. Special fertilizers are used to supply this element.

*Pruning* is essential for good fruit production. Peach trees are pruned more heavily than most other fruit trees. Trees are pruned low to make spraying and picking easier. Because the fruit is produced on shoots of the previous season's growth, about a third of the last year's growth is kept. The trees produce so many peaches that the fruit must be thinned. Growers remove some peaches early in the season. This technique increases the size and improves the quality of the fruit that remains. Tree-ripened peaches have the best flavour. They are harvested when they are ripe but still firm.

**Uses.** Fresh peaches are eaten as a delicacy. But many of the fruits are canned, principally those of the clingstone cultivars. Some peaches are frozen for commercial use, and a few of the fruits are dried. Pastries and preserves can be made from peaches. Distillers sometimes make brandy from them.

**Diseases.** A number of diseases attack the peach. *Brown rot,* a fungus, causes serious damage. It rots the fruit and prevents the flowers from opening. *Peach leaf curl* is very troublesome. To prevent it, growers spray the tree early in spring before the leaves emerge. Other fungi cause *mildew, rust,* and *blight.* Sprays of organic chemical fungicides are used to control these diseases.

Peach trees are susceptible to many virus diseases. Among the serious ones are *peach yellows, X-disease, Western X-disease, ring spot,* and *peach mosaic.* Trees infected with these diseases must be uprooted.

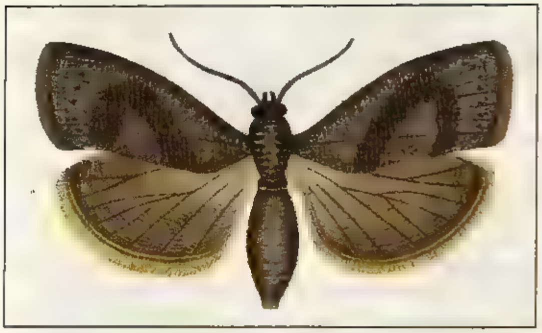
**Insects.** Several insects damage peach trees. The *peach twig borer,* the larva of a moth, may bore into the fruit. But usually it bores into the trunk and branches, sometimes killing the tree. The Oriental fruit moth larva destroys twigs and fruit. Many other moth larvae and beetles prey on the foliage, as do several kinds of caterpillars. Organic chemical insecticide sprays are used to control insects.

**World production.** During the 1980's Italy overtook the United States as the world's largest producer of peaches. Italy produced 1.5 million metric tons in 1988, about a sixth of the total world annual peach harvest of 8.2 million metric tons. The U.S. crop for 1988 was some 1,370,000 tons. Other important producer countries include Spain (655,000 metric tons), China (641,000 metric tons), Greece (591,000 metric tons), and France (457,000 metric tons).

**Scientific classification.** The peach tree belongs to the rose family, Rosaceae. It is *Prunus persica.*

**Peach moth** is a small, mottled brown moth. It is also called the *Oriental fruit moth,* because it is thought to have originated from Japan. It is one of the most serious pests of peaches. The peach moth winters as a larva in a cocoon under loose bark or rubbish. The adults emerge when peaches are blooming. They lay eggs on leaves, and the eggs hatch into larvae. From four to seven generations of larvae appear yearly. The first generation eats tender twigs. The later generations feed upon the fruit.

The peach moth also attacks apples, pears, quinces, cherries, and plums. Parasitic wasps and flies, including some imported from abroad, assist in controlling the moth.



**The peach moth damages peaches and other fruit.**

A synthetic *pheromone* is sometimes sprayed on peach orchards to keep peach moths from mating (see **Pheromone**). Insecticide sprays may be needed to control large numbers of the moths.

**Scientific classification.** The peach moth belongs to the family Tortricidae. It is *Grapholita molesta*.

See also **Codling moth**.

**Peacock,** also called *peafowl,* is one of the showiest of all birds because of its great size and the beauty of its feathers. Technically, the word *peacock* refers only to the male peafowl. The female bird is called a *peahen*. However, most people use the term *peacock* for both.

The Indian peafowl is the best-known species. The male is about as large as a turkey. It has a metallic greenish-blue neck and breast, purplish-blue underparts, and a long train of greenish feathers brilliantly marked with bold spots that look like eyes. These feathers grow from the back and not the tail. During courtship, the male bird spreads the train into a gorgeous fan as he parades slowly in front of the female. The female bird is smaller and less vividly coloured than the male bird. The female bird has no train.

Indian peafowls live wild in India and Sri Lanka, and can be seen in city parks and on country estates. The dark-green, broken coloration may have protective value in the midst of colourful tropical foliage. These birds eat snails, frogs, and insects, as well as grain, juicy grasses, and bulbs. They often destroy crops. Varieties with white plumage are sometimes found in captivity. The green "jungle" peafowl, found in Burma, Malaysia, and Java, has a golden-green neck and breast.

Tame peacocks may be found in all parts of the world. The young cannot stand the changeable weather of temperate climates very well, and are hard to raise. The hen makes its nest in a protected spot on the ground. It lays 10 or more brownish eggs.

In ancient times, the peacock was carried to all parts of the world as a great treasure. During the reign of Solomon, "once in three years came the navy of Tharshish, bringing gold and silver, ivory, and apes, and peacocks" (I Kings 10: 22). The peacock is mentioned in *The Birds*, a play by Aristophanes, written in Greece during the 400's B.C. In ancient Rome, the peacock was considered a great delicacy as a roast, served in its own feathers.

**A male peacock** can spread the feathers on its back into a beautiful fan. These feathers, called a *train*, are about five times as long as the bird's body.

**Scientific classification.** Peacocks belong to the family Phasianidae. The Indian peafowl is *Pavo cristatus.* The green peafowl is *P. muticus.*

**Peacock, Thomas Love** (1785-1866), an English novelist and poet, wrote a number of satirical novels. They are *Headlong Hall* (1816), *Melincourt* (1817), *Nightmare Abbey* (1818), *Crochet Castle* (1831), and *Gryll Grange* (1860). Within these novels, a number of unusual characters, caricatures of various contemporary social types, meet at a country house and hold long discussions, criticizing people, customs, politics, and manners. The novels include songs, poems, and nonsense verse.

Peacock was born at Weymouth, in Dorset. He was initially self-educated, but became a learned scholar. He was a close friend of the poet Percy Bysshe Shelley.

**Peafowl.** See Peacock.

**Peak District** is a hilly region at the southern end of the Pennine Hills, in England. It lies mainly in Derbyshire. The region includes a national park. The uplands of the High Peak include The Peak, 636 metres high, also known as Kinder Scout. To the north, and over the Snake Pass, rises Bleaklow Hill, 628 metres high. Near the Snake Pass are the Derwent and Ladybower reservoirs. Within the Peak District is the attractive area known as the Dales. Touring centres include Buxton and Matlock.

**Peale** was a family of famous American artists. At least 20 members of the family, covering three generations, were artists. Charles Willson Peale (1741-1827), the enthusiastic family patriarch, believed that anyone could learn to draw. He taught many of his 17 children and also his brother James Peale (1749-1831). James in turn taught five of his children. James painted portraits, figure compositions, landscapes, and still lifes. They were done with the directness and charm that mark the best work of the family.

Raphaelle Peale (1774-1825) and Rembrandt Peale (1778-1860) are the best known of Charles Willson Peale's artist sons. Raphaelle is noted for his still lifes and miniatures. Rembrandt painted hundreds of portraits. Sarah Miriam Peale (1800-1885), a daughter of James, was probably the first professional woman portrait painter in America.

Oil painting on canvas (1770-83; 1808) the New-York Historical Society, New York City

**Charles Willson Peale** painted this picture of his family after studying under Benjamin West in London.

Charles Willson Peale gave up painting in middle age to devote full time to his natural history museum in Philadelphia. His finest painting, *The Staircase Group* (1795), contains life-size portraits of his sons Titian and Raphaelle.

See also **Lafayette, Marquis de** (picture). (Museums).

**Peanut** is a plant species grown mainly for its fruit. The peanut is a *legume*—that is, it bears fruit in the form of *pods* (shells) that contain one or more seeds. The peanut is more closely related to peas than to nuts. There are two seeds in most peanut pods. These tasty seeds are also called peanuts. They are a favourite food, whether eaten alone or mixed into sweets, cakes, or pies. Peanut butter is also a popular food. Worldwide, peanuts are grown chiefly for oil.

The peanut plant is unusual because its pods develop underground. For this reason, peanuts are often called *groundnuts.* Other names for peanuts include *arachides, monkey-nuts, mani,* and *pinders.*

Peanuts are an important crop, especially in the warm regions of the world. Farmers in Africa and Asia grow about 85 per cent of the world's peanuts. The leading peanut-growing countries, in order of production, are India, China, and the United States.

Peanuts are a nutritious food. There are more energy-giving calories in roasted peanuts or peanut butter than in an equal weight of beefsteak.

### Uses of peanuts

**As food.** Manufacturers roast peanuts inside the pods and sell them as whole *roasted-in-shell* peanuts. They also remove the shells and roast and sell only the seeds. Peanuts are usually salted to improve their flavour.

Manufacturers make *peanut butter* by roasting and *blanching* (removing the skins or seed coats from) the peanuts, and then grinding them into a thick paste. Peanut butter is eaten alone and in sandwiches.

Roasted peanuts are eaten alone or mixed into sweets, cakes, pies, and other bakery products. Some ice cream is flavoured with peanut butter. *Peanut bread* is made from ground peanuts. Peanut bread is rich in proteins and low in starch. Peanuts are sometimes sold fresh as *boiled peanuts.* Instead of drying the peanuts after picking, farmers wash the peanuts and boil them in salt water.

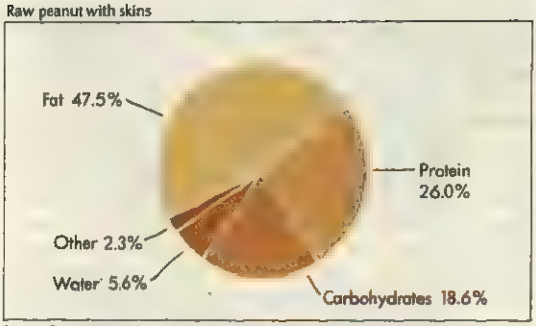
Peanut seeds consist of almost 50 per cent oil. Peanut oil is used to fry foods. It smokes only at high temperatures and does not absorb odours easily. Many salad oils and dressings, margarine, and other vegetable shortenings also contain peanut oil. The oil content of the peanut varies in different varieties. It can be as high as 48 per cent, but not all of this can be extracted. An average figure of 36 per cent oil is used for calculating the oil content of combined varieties of peanuts.

**In industry.** Low grades of peanut oil are used as an ingredient in soaps, face powders, shaving creams, shampoos, and paints. They are also used in making *nitroglycerin,* an explosive. Peanut oil has also been tested as an alternative fuel source.

The solid that remains after the oil is removed from peanuts is a high-protein livestock feed. Peanut protein can also be used to make a textile fibre that is called *Ardil.*

**Food value of the peanut**

Raw peanut with skins




Source: *Composition of Foods*, Agriculture Handbook No. 8, Bernice K. Watt and Annabel L. Merrill, U.S. Department of Agriculture, 1963

Even the shells of peanuts have uses. Manufacturers grind the peanut shells into powder. This is used in plastics, cork substitutes, wallboard, and abrasives.

**On farms.** Peanut foliage makes good hay. But most farmers return the harvested plants to the ground to fertilize the soil.

## Growing peanuts

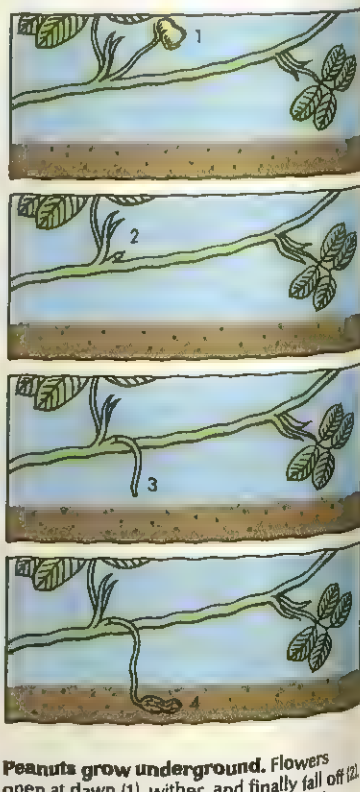
**The peanut** is grown as an annual crop. It can grow up to about 75 centimetres high and about 90 to 120 centimetres across. Peanut plants range in type from *bunch* plants to *runner* plants. Bunch plants grow upright. Runner plants spread out on or near the ground as they grow. Growers group peanuts into four market types: (1) large-seeded Virginias; (2) smaller-seeded Virginias, called *runners;* (3) Spanish; and (4) Valencia. Both kinds of Virginias include bunch and runner plants. Spanish and Valencia types are bunch.

Peanut plants bear many small, yellow, pealike flowers where the leaves are attached to the stems. The plants blossom continuously for two to three months. Flower buds open at sunrise. Fertilization takes place during the morning, and the flowers usually wither and die about noon. Within a few days, the *pegs* (stalklike stems of the pods) begin to grow.

The pegs grow downward and push into the soil to a depth of 2.5 to 8 centimetres. The grown pegs may be about 18 centimetres long. The tips of the pegs contain the developing seeds. They swell and mature into peanut pods. Most pods contain two seeds, but some may contain only one or as many as five seeds.

**Cultivation.** Peanut plants grow best in light, well-drained, sandy soil. They need much sunshine, warm temperatures, moderate rainfall, and a frost-free growing period of four or five months.

Farmers prepare the soil by ploughing it deeply and thoroughly. Loose soil is important so that the pegs can penetrate the soil easily. Farmers plant peanut seeds 5 to 8 centimetres deep at intervals of 8 to 15 centimetres, and in rows about 60 to 90 centimetres apart.




**Peanuts grow underground.** Flowers open at dawn (1), wither, and finally fall off (2). The base of each fertilized flower then begins to grow (3), forming a *peg* (stalklike stem). The peg pushes down into the ground. Its tip swells and grows into a peanut pod (4).

**Farmers harvest peanuts** with a *peanut combine.* The combine picks up the plants after they have been dug, strips the pods from them, and places the pods in a large collecting bin.

Farmers must harvest peanuts at exactly the right time. If they harvest their crops too early, many pods will not have ripened. If they harvest them too late, the pegs may snap, and many pods will be left in the soil. Most pods ripen 120 to 150 days after planting.

At harvest time, farmers use mechanized diggers to slice through the *tap* (main) root of each plant below soil level. The plants, with pods attached, are dug from the soil and turned upside down to dry in the sun. Special machines called *peanut combines* remove the pods from the sun-dried plants. The pods are further dried artificially in wagons. The pods are cleaned and graded before they are shelled for processing.

### Processing peanuts

Most shelled peanuts are either *oil roasted* or *dry roasted.* Oil roasting is the more widely used method. In this process, manufacturers blanch the peanuts and fry them in oil. Dry-roasted peanuts are glazed with oil, sprinkled with salt, and roasted in large ovens.

Over 60 per cent of the world's peanut production is used to produce oil. Some processors use a chemical *solvent* to dissolve oil from the peanuts. The oil is recovered from the solution by evaporation. In another method, peanuts are ground and pressed in large tube-shaped grinders. The oil is collected, filtered, and deodorized. The *peanut meal* left over after the oil is extracted is sometimes ground into peanut flour. In some countries, people eat peanut meal as a high-protein meat substitute.

### History

Peanuts are native to South America. South American Indians were growing peanuts at least 1,000 years ago. Early North American settlers grew peanuts, but no one knows whether peanuts were cultivated in North America before the settlers arrived.

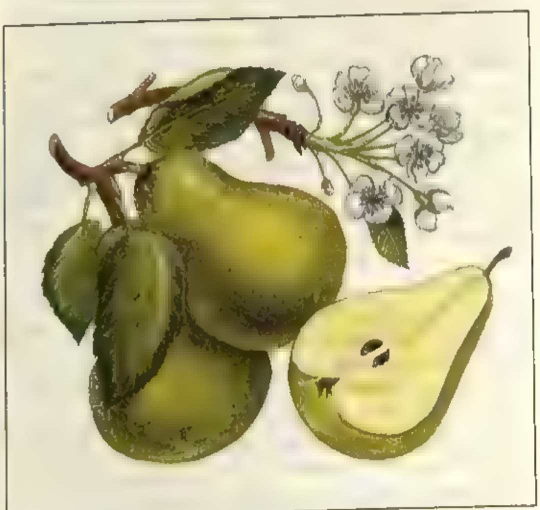
Early in 1947 the British Government launched a scheme to make the then Crown colony of Tanganyika—now the Republic of Tanzania—a major peanut-producing country. An annual production of 800,000 tons of oil seeds was envisaged. The scheme proved to be a costly failure and was finally abandoned in the 1950's. Tanzania currently harvests about 60,000 metric tons of peanuts in shell.

**Scientific classification.** Peanuts belong to the pea family, Leguminosae. Cultivated peanuts are *Arachis hypogaea.*

**Pear** is a fleshy fruit. Some pears are large and round at the blossom end and taper inward toward the stem. Others may be almost completely round, like an apple, or as small as a cherry. The pear tree is closely related to the apple and the quince. It grows in temperate regions throughout the world. The *common,* or *European,* pear is native to southern Europe and Asia. The *Japanese* and *Chinese* pears, often called *oriental* pears, are descended from the wild *sand* pear of central and western China. There are many hundreds of pear varieties. Pears are often grown in gardens, but the pear has never become as popular as the apple.

The fruit is covered with a smooth, thin skin, which

**Pear trees** grow throughout Europe and other temperate regions of the world.



**Pears** vary in shape, but they are generally round at the bottom and narrow near the stem. The flesh is sweet and juicy.

may be yellow, russet, or red. Its juicy flesh is sweet and mellow. It is also tender, though tiny, hard grit cells make the flesh of some pears taste sandy. European pears contain only a few of these cells. But fruits of other kinds of pear trees may have large numbers of them. Enclosed in the centre of the fleshy portion is a core much like the core of an apple. This core may contain as many as 10 seeds. Pears from different varieties vary in shape, size, colour, texture, flavour, aroma, time of ripening, and keeping qualities.

The common pear tree may grow 14 metres high and be 8 metres wide. It sometimes lives to be quite old, often more than 75 years. Its leaves are almost oval but have a sharply pointed tip. They usually have toothed edges and prominent veins. The white flowers grow in clusters of 4 to 12 blossoms.

**How pears are grown.** Pears, like most other fruit trees, are grown by grafting the desired variety on a rootstock. Seedlings of European pears are usually used for rootstocks. They are called French pear seedlings, even though the seeds are no longer imported from France. The seeds for the rootstock are usually from Bartlett pears.

Quince rootstock is used to produce dwarf pear trees. But some European pear varieties will not grow on quince. Then the grower uses an intermediate stock. To do this, the grower first grafts the intermediate stock, which will grow on the quince. When the intermediate stock shoots are long enough, the European variety wanted is grafted to the shoot. Then the grower cuts off all side growth except that on the last graft.

Growers plant standard-sized trees about 5 to 8 metres apart. They plant dwarf trees about 3 to 4.5 metres apart. Pear trees grow well in soils heavier and wetter than those in which peach trees will grow. Pears are more tolerant of poor drainage than apples, but do not generally survive dry soil conditions. They grow best on fertile *loam* (a rich soil made up of clay, sand and decomposed plant material). Sometimes fertilizers are added to the soil to increase the growth of the tree. Pear trees do best on a sheltered site protected against frosts. They should not be planted at the bottom of slopes where cold air accumulates. In some regions, certain varieties may not need cross-pollination to bear fruit. But in other regions, the same varieties may need to be cross-pollinated. Some varieties always need cross-pollination.

Growers prune pear trees as they do some other orchard fruit trees. They cut off unnecessary branches so light can reach all parts of the tree. They also keep the tree quite low to make it easier to spray and pick the fruit.

Some pear trees seem able to withstand very cold weather. Therefore, certain varieties can be grown in regions that have severe winters. However, many pears thrive in hot, dry areas. Hybrids produced from common and Japanese pears are quite hardy.

**Varieties.** From the common, or European, pear have come such familiar varieties as Bartlett, Comice, Anjou, Bosc, Hardy, Seckel, and Winter Nelis. Because of the gritty nature of the fruit of some older varieties, which is objectionable to many people, oriental pears were crossed with the common pear. From this crossbreeding come the varieties Kieffer, LeConte, and Garber. However, some extremely fine varieties of oriental pears have become available.

Bartlett pears ripen in summer, but most other varieties ripen later, usually in early autumn. Oriental pears ripen well on the tree. Other pears ripen to perfection only when they are removed from the tree. Therefore, these pears are picked while they are still green and hard. The fruit will ripen in a cool place where the temperature does not exceed 24° C. Many varieties, such as Winter Nelis and Forelle, can be kept in cold storage all winter. Temperatures range between 0° C and 4° C. Most other pears, such as Comice and Anjou, must be removed from storage by midwinter.

**Uses.** Pears are used widely as a dessert fruit. About half of all pears grown are eaten fresh. But many are canned alone or in combinations with other fruits. Some pears are dried. Europeans use pears for pear cider, called *perry.*

**Food value.** Fresh pears contain about 14.1 per cent carbohydrates and a small amount of protein and fats. They also contain calcium, phosphorus, iron, vitamin A, thiamine, riboflavin, niacin, and ascorbic acid. Pears have as many calories as apples, but more calories than peaches. Pears have fewer calories than either plums or cherries.

**Diseases.** Perhaps the greatest limiting factor in growing the common pear is the occurrence of fire blight. This disease is often called *pear blight* because pears are so susceptible to it. Fire blight is a destructive disease that spreads rapidly in warm, humid weather. It is caused by bacteria that attack blossoms, young twigs, and branches, killing them and turning them black, as if they had been burned by fire. The bacteria live from year to year in cankers on the tree trunk and limbs. Insects carry them from tree to tree. Rain, dripping through the tree, carries them from branch to branch. Contaminated pruning tools also spread the disease. Growers prune away all the diseased parts as soon as they are noticed. The growers also spray the tree with a copper solution, or with solutions containing antibiotics such as terramycin and streptomycin. Other damaging diseases include false fire blight, leaf spot, pear decline, powdery mildew, scab, and collar rot.

**Leading pear-producing countries**

| Annual pear production | |
|---|---|
| China | 2,705,000 metric tons |
| Italy | 797,000 metric tons |
| United States | 764,000 metric tons |
| Spain | 550,000 metric tons |
| Soviet Union | 500,000 metric tons |
| Japan | 472,000 metric tons |
| France | 344,000 metric tons |

Figures are for 1989.
Source: *FAO Production Yearbook, 1989,* Food and Agriculture Organization of the United Nations.

**Insects.** The codling moth is a serious pest. It causes wormy fruit. Pear psylla affects the skin of the fruit and the tree's foliage. Pear-leaf blister mite and various other mites cause brownish blisters on the undersides of the leaves. They also cause the fruit to be small and to fall. Pear thrips attack the buds early in spring, causing them to shrivel and turn brown. A sawfly known as the pear slug damages trees by eating the leaves. Other pests include aphids, leaf rollers, lygus bugs, midges, oriental fruit moths, scale insects, slugs, and stink bugs.

**History.** No one knows when pears were first found. The Greek poet Homer, who may have lived during the 700's B.C., mentioned this fruit in his works. So did the Roman playwright Publilius Syrus. In Europe, thousands of varieties of pear have been cultivated since ancient times.

**World production.** Total world production of pears by the end of the 1980's was 9.7 million metric tons. China, which harvested 2,580,000 metric tons, was the world's biggest producer, followed by Italy and the U.S.A. Other significant producers of pears are Africa, Australia, Bulgaria, France, Germany, Japan, Turkey, and South Africa.

**Scientific classification.** The pear tree belongs to the rose family, Rosaceae. The common, or European, pear is *Pyrus communis*. Most oriental pears are *P. pyrifolia*. Others are the Ussurian pear, *P. ussuriensis*, and the Callery pear, *P. calleryana*.

See also **Blight; Fruit** (table: Leading fruits).

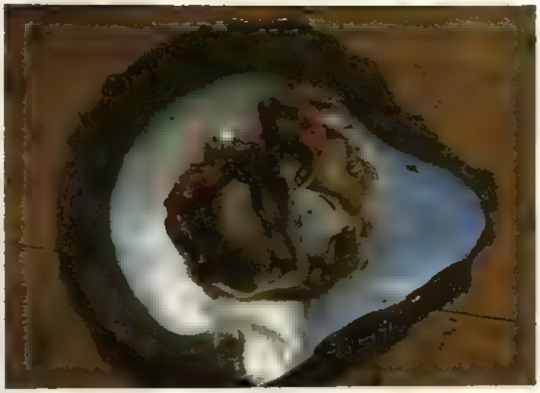
**Pearce, Bobby** (1905-1976), an Australian rower, became one of the greatest scullers of all time. He won gold medals in single sculls events at the Olympic Games in Amsterdam in 1928, the British Empire Games in London in 1930, and the Olympic Games in Los Angeles in 1932. He also won the Henley Diamond Sculls in 1931. He became a professional after the Los Angeles games and won the world title. He successfully defended his world title on a large number of occasions over many years and retired undefeated. Pearce was born in Sydney.

**Pearce, Philippa** (1920- ), is an English writer of children's books. She became best known for her fantasy *Tom's Midnight Garden* (1958). This book, which has become a classic of children's fiction, tells about a boy who finds a garden from the 1800's in a relative's home after he hears a clock strike 13.

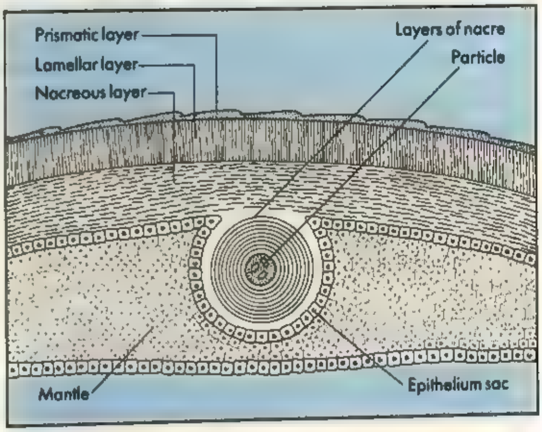
Pearce's adventure story *Minnow on the Say* (1955) deals with two boys on a treasure hunt. Her realistic tale *A Dog So Small* (1962) concerns a boy who yearns for a dog. Pearce's other books include *Mrs. Cockle's Cat* (1961) and *The Squirrel Wife* (1971). She also wrote the short-story collections *What the Neighbours Did and Other Stories* (1972) and *The Shadow Cage and Other Tales of the Supernatural* (1977).

Ann Philippa Pearce was born in Great Shelford, near Cambridge, England. The village provides the setting for most of her fiction.

**Pearl** is one of the most valuable gems. Large, perfectly shaped pearls rank in value with the most precious stones. But pearls are different from other gems. Most gems are minerals that are mined from beneath the earth. But pearls are formed inside the shells of oysters. Mineral gems are hard and usually reflect light. However, pearls are rather soft, and they absorb, as well as reflect, light.



**A pearl** forms inside the shell of an oyster, *above*. The pearl begins when a particle of foreign matter enters the shell. Over a period of years, the oyster covers the particle with many thin layers of a substance called *nacre*, forming the pearl, *below*.



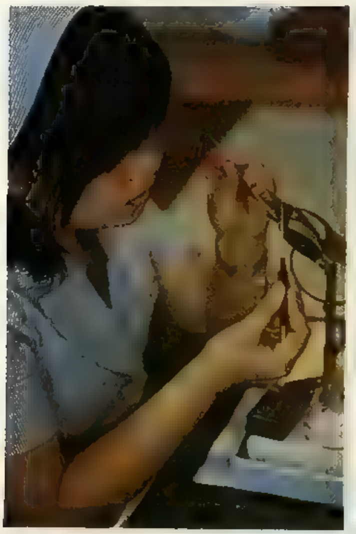

### How pearls are formed

Oysters and other shell-forming molluscs make a special substance, called *nacre*, that lines the insides of their shells. This smooth lining is called the *nacreous layer*, or *pearly layer*, and is often lustrous. It is formed by cells from a fleshy body organ called the *mantle*. When a foreign substance, such as a bit of shell or a tiny parasite, enters the body of the mollusc, the mantle cells begin to work. They cover the invading substance with thin sheets of nacre. They build successive circular layers of nacre until the foreign body is enclosed in the shell-like substance, forming the pearl.

The pearl has the same lustre and colour as the lining of the shell of the mollusc. But few pearl-forming molluscs produce the beautifully coloured nacre that is essential for valuable pearls. Valuable pearls come from some species of oysters and other molluscs that live in tropical seas. Some species of mussels found in rivers also produce precious pearls. Edible clams and oysters have dull shells, so their pearls are without lustre. As a result, they have no value as gems.

### Characteristics of pearls

When a pearl is cut in two and examined under a microscope, the layers can be seen. Because the layers are



**Production of a cultured pearl** begins when a worker inserts a tiny pellet made from nacre or mussel shell into an oyster. The oyster then makes the pearl.

**The shape of a pearl** helps determine its worth. The three round pearls at the top are more valuable than the six irregularly shaped pearls below them.

**A worker sorts pearls** by size, arranging them in a special grooved box. Later, holes will be drilled into the pearls and they will be strung into necklaces.

*concentric* (formed in a complete circle around the central substance), the cut pearl looks like a sliced onion. The layers are made up of little crystals of a mineral substance called *aragonite,* a form of calcium carbonate. They are held in position by a cartilagelike material known as *conchiolin.* The tiny mineral crystals overlap, and break up any light that falls on them into little rainbows of colour. This gives pearls their iridescence, which jewellers call *orient.*

Conchs, clams, and most edible oysters usually do not make pretty pearls because their aragonite crystals are too large. Even though the pearls may be of beautiful pink, white, or purple colour, they lack iridescence.

**Colour.** Oriental pearls, so called not because they come from the Far East but because they are iridescent, may also have colour. These pearls may be "black," pink, orange, gold, cream, or white. "Black" pearls are really a dark grey. They are among the most valuable of all pearls.

**Shape** of a pearl is as important as its colour. Round pearls, suitable for necklaces, are the most valuable. Next in value are the button-shaped and drop-shaped pearls. These are often used for earrings. Matched pairs of these pearls are even more valuable than pairs of unmatched single ones. Pearls with irregular shapes are called *baroques.* They are less valuable than the others. Pearls made by a kind of snail called an *abalone* have wonderful colour and lustre but are almost never symmetrical.

**Blemishes.** Perfect pearls and pearls with only one blemish are the most valuable. Sometimes pearl blemishes can be removed if the flaw is not too deep. Specially trained workers, called *peelers,* carefully scrape away the blemished layers. When they have removed the flaw, the pearl is smaller, but perfect. Such a pearl is worth more than the original large, but blemished, pearl.

**Matching pearls.** The matching of pearls to make a pair or a string makes the finished piece more expensive than the total cost of the individual pearls. Each added pearl must be like all the others in colour and orient. Often it must be of the same size as the others. It must have no more than one tiny blemish. One blemish is acceptable because the pearl can be drilled for mounting at the blemish. Before people began to produce cultured pearls, it could take many years to fill a necklace of matched pearls.

**Value.** The cost of pearls sold in large quantities is determined by their weight. In a piece of jewellery, the value of a pearl is determined by its size, colour, and lustre. For example, matched pearls in a necklace cost more than the total of their individual values.

## Kinds of pearls

**Natural pearls.** Until the 1940's, the chief pearl-oyster beds were found in the Persian Gulf, near the island country of Bahrain. Other natural pearl-oyster beds were located in the South Pacific Ocean. Thousands of oysters had to be collected to produce even a small handful of pearls. For this reason, natural pearls were extraordinarily expensive. Today, few natural pearls are harvested for jewellery because the farming of cultured pearls produces pearls more cheaply.

**Cultured pearls** are real pearls made by oysters. They usually can be distinguished from natural ones only by tests made in laboratories. The cultured pearl has a larger central body around which the layers of nacre form. The cultured pearl also has fewer and thicker layers of nacre. Thicker layers of nacre increase the value of the pearl.

Cultured pearls were first produced by inserting in an oyster a bead made of *mother-of-pearl,* the nacre secreted by certain inedible clams and oysters (see **Mother-of-pearl**). A small amount of mantle tissue from an-

other oyster also was inserted. The process was developed by Kokichi Mikimoto of Japan in the early 1900's. So successful was this process that the cultured-pearl business became much larger than the trade in natural pearls. Today, most cultured pearls are produced in Japan.

To produce cultured pearls, young oysters are planted in carefully selected oyster beds. When the oysters are 3 years old, they are taken from the beds to special production plants. There, trained people open the oysters' shells and insert tiny pellets made of nacre or made from mussel shells. The workers then place the oysters in wire cages that will protect them from enemies. The cages are suspended from rafts and lowered into calm, protected waters near the shore.

Twice a year attendants raise the cages and remove seaweed and barnacles from the oysters. Progress of the oysters and the care given them are recorded on small metal tags attached to the cage. From one to three years after the pellets and tissue are inserted, the oyster is removed from the cage and its shell is opened. There is a valuable pearl in about 1 out of every 20 oysters opened. The pearl is washed, graded, and polished before it is sent to market.

**Imitation pearls** are manufactured. Usually, manufacturers coat glass beads with a substance known as *pearl essence.* This substance, sometimes known by its French name *essence d'orient,* is a creamy liquid extracted from fish scales. Herring scales usually furnish the main ingredient. Imitation pearls can be recognized by the little loose flaps of dried pearl essence surrounding the hole. Often a little of the glass bead that the pearl essence has failed to cover can be seen at this place on the pearl.

### Care of pearls

Because pearls are soft, they are easily scratched by such hard gems as diamonds. Pearls should always be put away carefully, out of contact with other jewellery. Pearls contain an organic material, conchiolin. This material dries out in time, or it can be destroyed by high temperatures. The aragonite crystals that make up the layers of nacre dissolve very quickly in acid. Perspiration sometimes contains acid. Therefore, jewellery made of pearls should be washed and dried gently after it is worn.

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| Birthstone | Gem (picture) |
| Button | Mollusc |
| Conch | Oyster |

**Pearl Harbor Naval Base,** Hawaii, U.S.A., is the hub of United States naval power in the Pacific Ocean. It covers 8,900 hectares on Oahu Island and lies west of central Honolulu. Most of the U.S. Navy's major commands in the Pacific have headquarters at the base. These include the Pacific Fleet and its fleet marine, service, and submarine forces; an antisubmarine warfare force; Fleet Air Hawaii; a naval shipyard; a supply centre; and an ammunition storage depot. The base supports the operations of the Seventh Fleet.

Pearl Harbor is one of the world's largest and best-sheltered naval anchorages. It is formed by two mouths of the Pearl Stream. The harbour occupies about 26 square kilometres of navigable water, and has three *lochs* (nearly landlocked lakes). Its name comes from the pearl oysters that once grew in its waters.

In 1887, King Kalakaua of Hawaii gave the United States the right to develop a coaling station at Pearl Harbor. The Navy made its first attempt to deepen the channel through the reef outside the harbour in 1902. But the first dry dock was not completed until 1919.

A surprise attack on Pearl Harbor by Japanese forces on Dec. 7, 1941, forced the United States into World War II. Vice-Admiral Chuichi Nagumo led a 33-ship Japanese striking force that steamed under the cover of darkness to within 320 kilometres north of Oahu. His carriers launched about 360 aeroplanes against the Pacific Fleet, under Admiral Husband E. Kimmel, and the Hawaiian ground troops under Lt. Gen. Walter C. Short. The first bombs fell at about 7:55 a.m. The chief targets were the eight American battleships among the 92 naval vessels anchored in the harbour. The United States had 18 ships sunk or severely damaged, almost 200 planes destroyed, and about 3,700 casualties. Kimmel and Short

**Pearl Harbor tribute,** the U.S.S. *Arizona* Memorial, stands above the partly submerged battleship. The memorial honours those who died in the surprise Japanese attack on Dec. 7, 1941. More than a thousand men are entombed aboard the *Arizona.*

were criticized for the U.S. losses. Several investigations were held following the attack. "Remember Pearl Harbor!" became the rallying cry for the United States in World War II. See **World War II** (Japan attacks).

See also **Yamamoto, Isoroku.**

**Pearlfish** is the name of about 25 species of small, elongated fish found in tropical and warm waters. Most pearlfish are about 15 centimetres long, with a long dorsal fin and a long anal fin that meet at the tip of the pointed tail.

Pearlfish live as *parasites* (organisms that live in or on other organisms) or as part parasites in the body cavities of clams, sea cucumbers, sea urchins, starfish, and tunicates. Pearlfish enter a sea cucumber tail first through the anus. Some species of pearlfish feed on the internal organs of the creatures they live inside. Pearlfish may get their name from one species that lives inside a pearl oyster's shell. Alternatively, the name may come from pearlfishes' silvery white translucent-colouring.

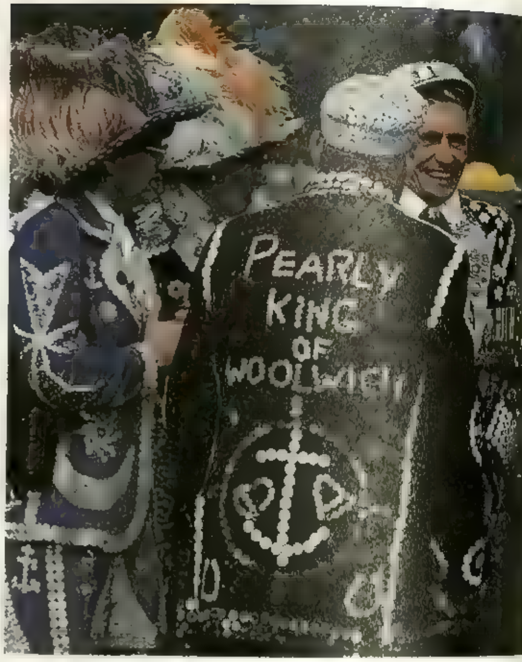
After hatching from the egg, a pearlfish passes through two distinct larval stages. The first larva is *pelagic* (swims in the surface water), the second larva is *benthic* (lives in or on the seabed).

**Scientific classification.** Pearlfish belong to the family Carapidae.

**Pearly kings and queens** are leaders chosen by London *costermongers* (street traders), who represent the costermongers on ceremonial occasions. Pearly kings and queens are so-called because of their traditional costume, which includes suits, hats, and coats covered with pearl buttons set in intricate designs. Pearly queens traditionally wear ostrich feathers in their hats.

Important occasions for pearly kings and queens include the Costermongers' Harvest Festival, usually held in October at the church of St. Martin in the Fields, in London. *Pearlies,* as the kings and queens are often called, also take part in the annual Lord Mayor's Show and a number of other functions to raise money for a variety of charities.

Costermongers have traded in London streets since medieval times, but the tradition of pearly kings and queens only developed at the end of the 1800's. Many pearlies have hereditary titles, but some pearlies are elected.




**Pearly kings and queens** are a feature of many ceremonial events in London, such as the Easter Parade in Battersea Park.

**Pears, Sir Peter** (1910-1986), was an English opera and concert singer of international repute. He developed a technique that made sensitive use of his tenor voice. He achieved fame with his singing of works by his friend Benjamin Britten. Pears was particularly successful in the opera *Peter Grimes* and the *War Requiem* by Britten.

Pears was born in Farnham, in Surrey, England. He began his career as an organist in Oxford, and later taught music in a school. In 1933, he began studies at the Royal College of Music. In 1948, he helped found the Aldeburgh Festival of music.

**Sir Peter Pears**

**Pearse, Patrick H.** (1879-1916), was an Irish writer and nationalist. He was one of the leaders of the Easter Rebellion in 1916. He and 14 other nationalists were shot for their part in the uprising (see **Ireland, History of**).

Patrick Henry Pearse was born in Dublin. He worked to promote the use of the Irish language. In 1908, he founded a school, St. Edna's, in which all of the pupils spoke Irish. Pearse's writings included numerous poems and stories in Irish.

**Patrick H. Pearse**

**Pearson, Sir Cyril Arthur** (1866-1921), was a British journalist and newspaper proprietor. He founded *Pearson's Weekly* in 1890 and the *Daily Express* in 1900. He became blind in his later years and, for this reason, sold the *Daily Express* to Lord Beaverbrook in 1919.

Pearson was born in Wookey, in Somerset, England. He was educated at Winchester College. Pearson founded St. Dunstan's, an institute for the welfare of blind soldiers.

See also **Beaverbrook, Lord.**

**Sir Cyril Arthur Pearson**

**Pearson, Karl** (1857-1936), a British geneticist, helped develop the science of statistics. He applied his statistical methods to biological data especially. In 1884, Pearson became professor of mathematics at the University of London. There he wrote his famous *Grammar of Science* (1892), a general textbook on scientific method. Later, Pearson developed an interest in biology and the new science of eugenics. Pearson was born in London.

Karl Pearson

**Pearson, Lester Bowles** (1897-1972), Canadian prime minister and educator, was an international statesman. He was the first Canadian to receive the Nobel Peace Prize (1957).

Pearson was born in Newtonbrook (now part of the city of Toronto) on April 23, 1897. World War I broke out in August 1914, and by the following March he had left his university studies in Toronto to enlist in the Canadian Medical Corps. In Europe, he served in the Balkans as a stretcher-bearer. Wounded British soldiers dubbed him "Mike," a nickname that stayed with him.

Commissioned a lieutenant in 1917, Pearson joined the Royal Flying Corps. He was injured in a bus accident in London and returned to Canada in April 1918. He then took up duties as a ground instructor.

After the war ended in November 1918, Pearson returned to the University of Toronto. He graduated with honours in 1919 and studied history at Oxford University in England from 1921 to 1923. He was in the Oxford hockey team, and also played in the British Olympic hockey team. From 1923 to 1928, he taught history at the University of Toronto.

In 1928, Pearson joined the Canadian diplomatic service. He participated in several international conferences during the 1930's and received the Order of the British Empire for his services. He was first secretary in the Canadian High Commissioner's Office in London from 1935 to 1941.

In the early 1940's, Pearson helped organize various United Nations (UN) food and relief programmes. He was the Canadian ambassador to the United States from 1945 to 1946, and a senior adviser at the San Francisco conference that signed the UN Charter in June 1945.

In September 1948, Pearson became Canada's secretary of state for external affairs. Cabinet ministers sit in the House of Commons, and for many years he represented a district in the province of Ontario. Pearson helped set up NATO. At the UN, he was president of the General Assembly (1952-1953).

In 1956, during the Suez Canal crisis, the UN accepted Pearson's proposal to end fighting and restore peace by sending an emergency UN force to Egypt. Britain, France, and Israel had invaded that country after it had seized the canal.

In January 1958, Pearson became leader of the Canadian Liberal Party. The party had fallen to the Conservatives in 1957, and it was defeated soundly in the election of March 1958. Pearson organized a new government, with the support of smaller parties, in April 1963. He had argued that Canada should accept nuclear warheads for missiles supplied by the United States. The Conservatives under John G. Diefenbaker had refused to do so.

Pearson spoke out against deeper U.S. military involvement in Vietnam in the 1960's. At home, he faced demands for greater recognition of rights for independence for the province of Quebec. Separatist bombings and other violent actions were directed against the national government.

The Canadian economy prospered during the 1960's and social services were increased. In April 1968, Pearson resigned as prime minister and head of the Liberal Party.

**Peary, Robert Edwin** (1856-1920), an American explorer, was one of the greatest Arctic travellers of all time. He became famous as the discoverer of the North Pole. However, some authorities have questioned whether Peary ever reached the pole.

**Early explorations.** In 1886, Peary travelled into the interior of Greenland. This experience interested him in undertaking further expeditions to explore the uncharted Arctic regions. In 1891, the Philadelphia Academy of Natural Sciences put him in charge of an expedition to northern Greenland. On this trip, Peary proved that Greenland is an island. Other trips between 1893 and 1897 resulted in important scientific discoveries about the polar regions. Peary published an account of these trips in 1898 in *Northward over the Great Ice.*

**North Pole journeys.** In 1898, Peary set out in his ship *Windward* to discover the North Pole. He was gone four years but did not reach the pole. His party surveyed the northern coast of Greenland and reached a latitude of 84° 17′ 27″, about 630 kilometres south of the pole. This was the farthest north that anyone had then gone in the American Arctic.

In 1905, Peary tried again to reach the North Pole. He sailed in the *Roosevelt,* a ship designed to sail among *floes* (masses of moving ice). His party left the ship on the north coast of Ellesmere Island and pushed northward on sledges over the ice fields of the Arctic Ocean. The party reached latitude 87° 6′, about 320 kilometres from the pole, a new "farthest north" record. But hardships forced the party to turn back. Peary's book *Nearest the Pole* (1907) tells of this journey.

In 1908, Peary again set out over the ice from Ellesmere Island, in a third attempt to reach the North Pole. On April 6, 1909, accompanied by four Eskimos and his chief assistant, Matthew Henson, Peary reached what he claimed was latitude 89° 57′, 5 kilometres from the pole. But he was too tired to go farther. He slept for a few hours and then pushed on. Two of the Eskimos went with him, but Henson did not. Peary and the Eskimos crisscrossed the area. In this way, they tried to make sure that Peary passed as near as possible to the exact point of the pole. Peary claimed that he reached the pole on April 6. He took soundings proving that the sea near the North Pole is not a shallow body of water, as scientists had believed.

**Dispute over Peary's claim.** Another American explorer, Frederick A. Cook, had announced just a week before Peary's return that he had reached the pole in April 1908, a year before Peary. But the U.S. Congress in-

vestigated Cook's claims and finally gave Peary credit for the discovery. Peary wrote an account of his trip in *The North Pole* (1910).

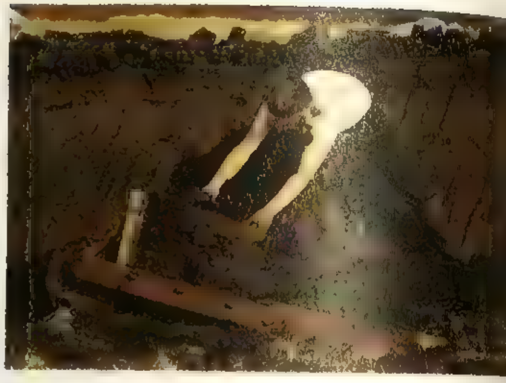
In 1988, the U.S. National Geographic Society asked Wally Herbert, a British polar explorer, to reexamine the journal Peary had kept during the third expedition. The society had helped support Peary's polar expeditions. Herbert found that the journal lacked entries for the days Peary said he had spent near the pole. Herbert also found that the journal contained evidence that Peary may have made navigational errors. According to Herbert, Peary had, for example, failed to adjust his route for a westward drift of the ice on which Peary was travelling. Also, Herbert noted that the expedition's *chronometer,* a special clock used in calculating location, had been 10 minutes fast. Herbert concluded that these and other problems may have taken Peary off course 48 to 96 kilometres to the west.

In 1989, however, a new study sponsored by the National Geographic Society concluded that Peary's final camp was probably no farther than 8 kilometres from the pole. The study was carried out by the U.S. Navigation Foundation. The foundation examined photographs taken at the Peary camp and determined that the angle of the sun was nearly the same as it would have been at the pole on the day that Peary said the photograph was taken. The foundation also found that Peary's ocean-depth measurements agreed with modern measurements taken along the route that Peary claimed he followed. In addition, the study concluded that the westward drift of ice noted by Herbert had later been offset by an eastward drift.

**Peary's life.** Peary was born in Cresson, Pennsylvania, U.S.A. From 1879 to 1881, he was a draughtsman for the U.S. Coast and Geodetic Survey in Washington, D.C. He then became a civil engineer in the U.S. Navy. Peary retired from the Navy in 1911.

See also **Cook, Frederick A.; Henson, Matthew A.**

**Peasants' Revolt.** See **Wat Tyler's Rebellion.**



**Peat bogs** furnish much of the fuel used in Ireland. The peat is harvested in blocks and dried before it is burned.

**Peasants' War** refers to the rebellion of German peasants against their lords in 1524 and 1525. This was the greatest mass uprising in German history. The rebellion broke out late in 1524 at Stühlingen in the Black Forest and spread northward like wildfire. Soon all Germany, except Bavaria, felt its impact. The peasants stormed the castles and forced the nobles to grant their demands. Their flag, called the *Bundschuh,* was a black, white, and red cloth with a picture of a peasant's shoe.

The peasants had grumbled over the ever-increasing taxes and services demanded by the princes for 50 years. The teachings of Martin Luther contributed to the peasants' rebellious feelings. The peasants hoped for Luther's support. However, he rejected their charter of liberties. Luther urged the peasants to lay down their arms. When the peasants did not do what he suggested, Luther summoned the lords in a pamphlet to strike down and stab the rebels "like mad dogs." The nobility killed as many as 100,000 peasants before the rebellion ended. The loss of so many people eliminated the peasantry as a political factor for the next 300 years.

**Robert E. Peary** won fame as a great Arctic explorer. The photograph at the left shows him after he returned from an expedition in 1909. Peary is usually credited with having discovered the North Pole on the expedition.

**Peat** is partly decayed plant matter that has collected in wetland areas known as peat bogs or peatlands over long periods of time. It is generally the first stage in the formation of coal. Dried peat varies from a light yellow-brown substance resembling tangled hay, to deeper layers of dark brown, compact material that looks like brown coal.

Peat forms in layers. The pale upper layers contain the remains of plants, herbs, and moss that died and rotted in the shallow, acid water. They are compressed by the weight of water and other plants to form peat. The lower layers are about 90 per cent water, and look like mud.

Peat is found throughout the world. Canada and Finland are among the countries with the largest deposits. Before its break-up the Soviet Union was the largest peat producer. Ireland, Germany, and other countries produced smaller amounts.

Most peat is harvested by machine. The machines dig, chop, and mix the peat and form it into blocks. The blocks are then spread on the ground for drying. Some peat is still dug and stacked by hand.

Dried peat is used mainly as a fuel in places where coal and oil are scarce. In Ireland, for example, peat is a major source of fuel to generate electricity. Black peat is used as a fertilizer. Fluffy brown peat is used as a packing material, and as bedding for farm animals.

Peat bogs take many hundreds, even thousands of years to develop. Conservationists are concerned these ancient, boggy landscapes be preserved, as they contain a rich variety of plant, insect and bird life.

See also **Coal** (How coal was formed); **Peat moss; Moss; Heather.**

**Peat moss** is a kind of moss from which peat is formed. Peat consists of partially decayed mosses and other plant matter that accumulate over long periods of time in marshy areas called *bogs* (see **Peat**). Peat mosses make up the *genus* (scientific group) *Sphagnum* and are often referred to as *sphagnum mosses.* About 200 species of peat mosses are found in bogs throughout Canada, northern Europe, and Siberia.

Peat mosses grow up 50 centimetres high. They typically grow close together and form dense mats that range in colour from dark-brown and red to yellow-green. Peat mosses are soft and spongy and have no true roots. They absorb and hold water in large, dead cells in the stems and leaves. These cells can store large quantities of water for long periods of time. Peat mosses also can make surrounding soil more acidic and thus delay the growth of fungi.

**Peat moss** usually grows in swamps. It is soft and spongy, forming dense mats.

Peat moss is often used in greenhouses and gardens. The moss is often spread on the surface of the ground to protect plants in hot, dry weather. Orchids and other rare plants are potted in peat moss to keep them from drying out. Peat moss also is used to cultivate mushrooms and as packing material.

**Scientific classification.** Peat mosses belong to the family Sphagnaceae. They make up the genus *Sphagnum.*

See also **Moss** (picture: Mosses).

**Pecan,** a tree native to North America, is valuable for its fruit, the pecan nut. The pecan is a type of hickory. It grows naturally in the Mississippi Valley region from Iowa southward, and in the river valleys of Oklahoma,

**The wide-spreading ornamental pecan tree** has golden yellow leaves in autumn. It produces a delicious, edible nut.

**The pecan nut** has a smooth shell, *bottom left.* Next to it is the meat of the nut. A husk encloses each nut, *far right.*

Texas, and northern Mexico. But pecan orchards are planted throughout the Southern United States as far north as Virginia, and in California. In addition, a small number of pecans are grown commercially in Australia, South Africa, and the Middle East.

Pecan raising is an important industry in the United States, especially in the South. Pecan orchards produce about 110 million kilograms of nuts in an average year. Some pecan trees produce up to 230 kilograms of nuts each year. However, the trees do not bear nuts until they are about five or six years old. For another five years, they do not bear enough nuts to be profitable. Only after the trees are about 20 years old does the owner receive a full return on the investment. Although the pecan is chiefly grown for its fruit, its wood is valuable for flooring, furniture, and panelling.

Pecan trees may grow 55 metres high. Their trunks are sometimes 1.2 to 1.8 metres in diameter near the ground, but most trees are smaller. The light brown or grey bark of pecan trees is deeply furrowed. The leaves are 30 to 50 centimetres long. They are made up of from 9 to 17 lance-shaped leaflets.

Pecan orchard trees are usually grown by grafting branch buds from trees that bear fine quality nuts on seedling stocks. In addition, pecan growers may manage and harvest nuts from groves of wild pecan trees. Pecan flowers are pollinated by the wind. However, most varieties of pecan trees are not pollinated by their own kind. For this reason, pecan orchards usually contain several different kinds of pecan trees. The thin-shelled pecans, called *papershell*, are popular because their shells can be cracked between the fingers.

Growers harvest the pecans after they fall to the ground. The nuts may fall naturally or be shaken off the trees using mechanical shakers. They are taken to processing centres where they are cleaned, graded, and packaged. The shelled nuts are cracked and most often sorted by machines.

**Scientific classification.** Pecans belong to the walnut family, Juglandaceae. They are *Carya illinoensis.*

**Peccary** is a hoofed animal that lives in forests and desert scrubs. It is distantly related to the wild pig. There are three living species of peccaries: (1) the *collared peccary*, or *javelina;* (2) the *white-lipped peccary;* and (3) the *tagua*, or *Chacoan peccary.* The collared peccary lives in South America and is found as far north as the Southwestern United States. The white-lipped peccary is found from central Mexico south to Paraguay. The tagua lives in the Gran Chaco region of Paraguay, Argentina, and Bolivia. Scientists discovered the tagua in 1975. They had previously thought that this species had become extinct more than 10,000 years ago.

**The collared peccary** has a coarse, blackish-grey coat. The animal has a lighter ring around its neck that resembles a collar.

Peccaries look much like slender pigs. The collared peccary stands about 55 centimetres high at the shoulder. It has a coarse, grizzled, blackish-grey coat with a grey collar. The white-lipped peccary is larger and darker. It is marked by white patches that extend from the mouth along the side of its face. The tagua, the largest living species, stands about 75 centimetres high at the shoulder. It has a coat of brownish-grey bristles with a grey collar. Peccaries have a large gland on their arched back, about 20 centimetres in front of the tail. When the animal becomes excited, the gland gives off a small amount of *musk*, a substance with a strong odour.

The mother peccary usually gives birth to twins, which are about the size of rabbits. The young have reddish coats with a black stripe down their backs.

Peccaries feed chiefly on roots and sometimes small animals. They travel in bands of up to several hundred individuals. They are shy, timid animals that flee from danger whenever possible. But if cornered, they fight viciously with their sharp teeth. Their most common natural enemy is the jaguar. Pigskin jackets and gloves are made from the thin, tough hides of peccaries. The skin can be recognized because the hair roots leave a pattern of three holes in evenly distributed groups.

**Scientific classification.** Peccaries make up the family Tayassuidae. The collared peccary is *Tayassu tajacu;* the white-lipped peccary, *T. peccari;* and the tagua *Catagonus wagneri.*

**Peck** is a unit of dry measure that is equal to 8 quarts or a fourth of a bushel (0.0088 cubic metre). Dry foods, such as potatoes and beans, are measured by the peck.

**Pecos Bill** is a cowboy hero in American folklore. He was the legendary inventor of roping, branding, and other cowboy skills. He also invented the six-shooter and train robbery and taught broncos how to buck.

According to legend, Pecos Bill was born in eastern Texas during the 1830's. He used a bowie knife as a teething ring and played with bears and other wild animals. During a trip west, Bill fell out of the family wagon near the Pecos River. He became lost and was raised by coyotes.

To win a bet, Pecos Bill once rode an Oklahoma cyclone without a saddle. The cyclone could not throw him and finally "rained out" from under him in Arizona. The rain fell so heavily that it created the Grand Canyon. Bill crashed in California, and the force of his fall created Death Valley. There are several versions of Bill's death. In one, he laughed to death after a man from Boston asked him silly questions about the West.

The legend of Pecos Bill developed from a magazine article written in 1923 by Edward O'Reilly, an American journalist. O'Reilly patterned Bill after Paul Bunyan and other legendary frontier heroes.

**Pécs** (pop. 177,104) is an industrial centre in the coal- and uranium-mining region of southwest Hungary. For location, see **Hungary** (political map). Pécs stands on the

site of an ancient Roman settlement. Hungary's first university was founded in Pécs in 1367. Other landmarks include a cathedral built in the 1000's and several structures built by the Turks, who occupied the city during the 1500's and 1600's.

**Pectin** is a substance found between the cell walls of many fruits. Pectin is used chiefly to thicken a mixture with which it is cooked. It makes such foods as jam, jelly, preserves, and relish "jell," instead of remaining thin and syrupy. Pectin has no nutritional value. It belongs to the carbohydrate group of foodstuffs, which includes starches and sugars.

The amount of pectin in a fruit depends on the species and ripeness. Some fruits, including apples, currants, grapefruit, oranges, and plums, are high in pectin. When such fruits are cooked to make jam, the pectin forms a network of fibres that thicken the fruit juices. Other fruits, such as apricots, cherries, pineapples, and strawberries, do not contain enough pectin to make them jell when cooked. However, commercial pectin can be added to thicken the mixture. This is available as a liquid or powder made from the rinds of apples and citrus fruits, especially lemons and oranges.

See also **Jam and jelly.**

**Pedagogy.** In ancient Greece and Rome, boys were accompanied to school by a slave called a *pedagogue.* The pedagogue taught the children and often protected them. The word *pedagogue* means a *leader of children.* Pedagogy today means the science and art of teaching.

Modern pedagogy emphasizes systematized learning, or instruction, dealing with the aims, principles, and methods of teaching. Such instruction is provided by the Department of Education in a university.

See also **Education.**

**Pedal wireless** is a crystal-controlled radio transmitter powered by electricity from a pedal-driven generator. The pedal wireless was invented in the early 1920's by Alfred H. Traeger, an Australian engineer, to provide a simple, inexpensive means of communication between isolated outback stations and the medical bases of the Australian Royal Flying Doctor Service. The operator needed no technical skill to use the wireless. The earlier models demanded a knowledge of Morse code, but Traeger developed a Morse typewriter that could transmit Morse letters.

**Pedal wireless** was invented in the early 1920's. It is powered by pedalling with the feet.

**Pedestrian.** See **Safety** (Pedestrian safety).

**The pedicab** was once a dependable taxicab in many cities in the Orient. Today, pedicabs are popular with tourists.

**Pedicab** is a type of three-wheeled vehicle used as a taxi. It is built like a bicycle, but has two rear wheels instead of one. The passenger carriage, which is often covered, sits above the rear wheels. The driver sits on a bicycle seat and pushes pedals that turn the rear wheels through a drive chain. He or she guides the pedicab with bicycle handle bars.

Pedicabs replaced *jinrikishas,* the hand-pulled carts that were once used as taxis in China, Japan, and many other Asian countries (see **Jinrikisha**). Motor vehicles have replaced pedicabs in the major cities of the Orient.

**Pedigree** is a record of the ancestors of an animal or plant. To be most useful, a pedigree should record *traits* (characteristics) of the ancestors as well as their names and their birth and death dates. Breeders use pedigree information to predict such traits as size, strength, and colour of hair in offspring. This information is considered so important in the improvement of livestock that breeders' associations have been formed to record the pedigrees of animals used for breeding. These animals are then said to be *registered.*

Pedigrees of plants are also helpful. But they are usually made for groups rather than individual plants. Records of human ancestry are sometimes called *family trees.* The study of some family pedigrees enables scientists to predict the inheritance of certain diseases and physical defects. See **Genealogy.**

See also **Breeding; Genetics; Heredity.**

**Pedometer** is a small instrument that measures the distance a person walks. It looks like a watch and is carried in the pocket. With each step, the motion of the body causes a small lever to move. This lever records the number of steps taken. To find out how far you have walked, you must find the average length of your step and multiply it by the number of steps recorded. In some pedometers, a mechanism accounts for the length of the step, and measures the distance walked.

**Pedro I** (1798-1834) was the first emperor of independent Brazil. He ruled from 1822 to 1831. Pedro was born in Lisbon, Portugal. He was the son of Prince John (later King John VI) of Portugal. In 1807, the Portuguese royal family fled to Brazil, a colony of Portugal, to escape capture by invading French troops. In 1821, John returned to Lisbon. He left Pedro to rule Brazil as prince regent.

Pedro was strongly influenced by a group of Brazilian-born counsellors who favoured independence for Brazil. On Sept. 7, 1822, he declared Brazil's independence. He was crowned emperor a few months later.

In 1826, John VI died, and Pedro became King Pedro IV of Portugal. Later that year, Pedro gave up the Portuguese throne. Strong-willed and undemocratic, Pedro became increasingly unpopular in Brazil. In 1831, he gave up the throne in favour of his son Pedro II.

**Pedro II** (1825-1891) was emperor of Brazil from 1831 to 1889. During his rule, slavery was abolished in Brazil.

Pedro II was born in Rio de Janeiro. In 1831, his father, Pedro I, gave up the throne, and Pedro II became emperor. Elected officials headed the government until 1840, when Pedro was declared old enough to rule on his own. Pedro gained respect as a moderate and humane ruler. Under him, Brazil helped overthrow Argentinian dictator Juan Manuel de Rosas in 1852. In 1867, Pedro's government opened the Amazon River to world commerce. Between 1871 and 1888, his government passed a series of acts abolishing slavery in Brazil. This action cost Pedro the support of Brazil's great landowners. In 1889, the army forced Pedro to give up the throne and formed a republic.

See also **Andrada e Silva, José Bonifácio de; Brazil** (Independence; The Age of Pedro II).

**Pedro Miguel Locks.** See **Panama Canal** (The Pedro Miguel and Miraflores locks).

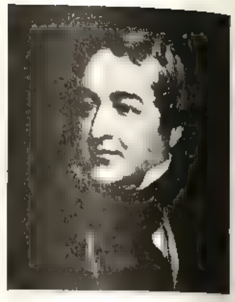
**Peeblesshire** was a small county in the Southern Uplands of Scotland. See **Borders Region.**

**Peel, Sir Robert** (1788-1850), was a famous British statesman. He founded the London police force in 1829. The police have been called *bobbies,* after Peel's nickname, ever since. Peel also served as Britain's prime minister in 1834 and 1835 and from 1841 to 1846.

Peel was born near Bury, England, the son of a wealthy textile manufacturer. He was educated at Harrow School and at Christ Church College, Oxford University, where he was awarded an honours degree in classics and mathematics. When Peel was 21 years old, he made his brilliant first speech in the House of Commons of the British Parliament. This speech led to the appointment of Peel as undersecretary for war and the colonies.

From 1812 to 1818, as chief secretary, Peel ruled Ireland with a firm hand. He maintained order by establishing an Irish police force, whose members were commonly called *Peelers.* His strong opposition to a measure permitting Roman Catholics to vote helped keep that proposal from becoming law until 1829. Such personal bitterness over the Roman Catholic question grew up between Peel and Daniel O'Connell, the Irish leader, that the two nearly fought a duel.

In 1819, Peel headed a commission to study British currency. He recommended reforms that gave Britain a sounder currency system. He became home secretary in 1822, but resigned in 1827 when George Canning became prime minister, because they disagreed on the Roman Catholic question. In 1828, Peel returned to office under the Duke of Wellington. Peel organized the London police force in 1829 to aid in enforcing the criminal code, which he helped reform. In the same year, the political situation caused him to change his mind on the Roman Catholic question. He helped prepare and pass the Catholic Emancipation Act, which gave the vote to Roman Catholics.



**Sir Robert Peel**

**Starts Conservative Party.** Peel went out of office again in 1830 when the Duke of Wellington's ministry fell. He opposed the Reform Bill, designed to give the vote to more people and better representation to new industrial towns. As a member of the minority opposition in the House of Commons, he formed the Conservative Party from the old Tory Party. Although the party was conservative in regard to the British constitution, Peel laboured to make the party concerned with the nation's welfare.

As leader of the Conservative Party, Peel served as prime minister for a short time in 1834 and 1835. He was also prime minister from 1841 to 1846.

**Prime minister.** Under Peel's leadership, certain important tax reforms were made. Circumstances caused him to change his mind in regard to the Corn Laws, which worked to the advantage of landowners by keeping food prices high. In 1842, Peel caused the laws to be amended so that prices would be lower. Then a famine in Ireland, which also resulted in great hardship in England, led him to favour repeal of the Corn Laws. Peel admitted that he could no longer answer the arguments of Richard Cobden of the Anti-Corn Law League, and he argued for free trade (see **Corn Laws**). Soon after the Corn Laws were repealed in 1846, Peel went out of office.

**Peel, Thomas** (1795-1864), was the promoter of the first settlement on the Swan River, near the present site of Perth, Australia. In December 1829, he landed at the Swan River with 300 settlers. The British government granted him 101,171 hectares of land in the newly established colony. The grant extended from Cockburn Sound to the Murray River. However, much of the land in the area was unsuitable for cultivation, and the colony began to fail.

In 1834, the government granted him another large tract of land at Mandurah. But he was unable to develop it, and died in poverty. Peel was born in England. He was a second cousin of Sir Robert Peel, who became prime minister of Britain.

**Thomas Peel**

The peel tower at Corbridge, near Hexham, in Northumberland, England, is a fortified home known as the *Vicar's Pele.*

**Peel towers** were medieval forts built near the border between England and Scotland. They protected their owners from raiders who crossed the border in search of plunder. The main living room of a peel tower was on the first floor. It was reached by a stone staircase, or by a ladder that could be raised in time of attack or siege. Originally, the word *peel* meant the wooden fence protecting the tower. Later, the word was applied to the tower itself. In some areas, the spelling *pele* is used.

Peel towers became obsolete in the 1600's, when James VI of Scotland, who became James I of England, stopped the border raids. Ruins of peel towers stand in many places in the border counties of England and in the two Scottish regions on the border.

**Peepul,** or bo tree, is a large kind of fig tree native to India and Southeast Asia. The peepul starts its life as an *epiphyte* (a plant that grows on other plants). The seeds, brought by birds, germinate on the branches of other trees, and grow down to the ground. Eventually a tree with many trunks is produced that splits apart the original host tree. The leaves of the peepul are triangular, with an elongated tip. The fruit is cylindrical and green-to-purple, with bright red specks. The tree is sacred to both Buddhists and Hindus. The peepul has many uses. For example, its bark is used as a source of paper, its leaves are a source of food for silkworms and are also used for miniature paintings, and its gum is used for sealing wax.

**Scientific classification.** The peepul belongs to the mulberry family Moraceae. It is *Ficus religiosa.*

**Peer group.** See **Adolescent** (Social development); **Child** (The preteenage years).

**Peer of the realm,** in the United Kingdom, is a man or woman who possesses a peerage, such as an earldom or a barony. A peerage gives its holder the right to be called "Lord" or "Lady" rather than "Mr." or "Mrs.", the titles used by *commoners* (ordinary people). Also, most peers over 21 are entitled to sit in the House of Lords of the British Parliament. They are not allowed to stand for election to the House of Commons, nor to vote in parliamentary elections. (The exceptions to this rule are peers of Ireland who have no other peerages. These peers may not sit in the House of Lords. They may therefore stand for election to the House of Commons and vote in elections.) Some peers inherit large estates, but others inherit nothing but their titles.

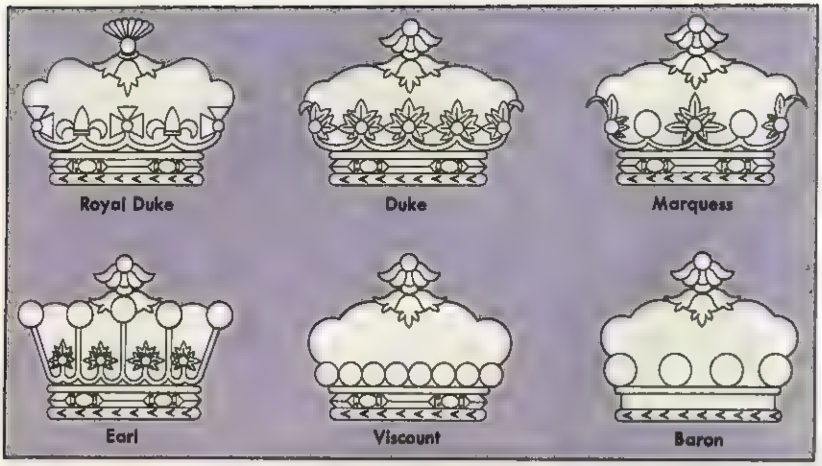
The *sovereign* (king or queen) creates new peers by issuing *letters patent* to them. These documents bear the sovereign's signature and the impression of the Great Seal. Britain has more than 1,000 peers. Most peerages are hereditary—that is, they pass to someone else on the death of the holder. In the majority of cases, a peer's title passes from a male peer to his eldest son. If he has no son, it can pass to his nearest male heir. Usually the heir must be descended from the first holder of the peerage. In some cases, women can inherit peerages.

### Degrees of the peerage

There are five degrees of the peerage: duke, marquess, earl, viscount, and baron. Each degree has five subdivisions, according to whether the peerage is one of England, Scotland, Great Britain, Ireland, or the United Kingdom. For example, dukes of England rank above dukes of Scotland. Then come dukes of Great Britain, dukes of Ireland, and dukes of the United Kingdom.

The origin of these degrees is historical. Before 1707, England, Scotland, and Ireland had separate peerages.

**Peers and peeresses,** such as this baroness, wear traditional robes when they are *inaugurated* (introduced) into the House of Lords and on other state occasions.




**Coronets** (crowns) are worn by peers on certain state occasions. Each rank of the peerage is indicated by its own coronet.

England and Scotland were united as Great Britain in 1707. Peerages created in the two countries after that date were peerages of Great Britain. Ireland joined Great Britain to become part of the United Kingdom in 1801. Nearly all peerages created after that date were peerages of the United Kingdom. But a few Irish peerages were created after 1801.

**Duke** is the highest degree of the peerage. The word *duke* comes from the Latin word *dux,* meaning *leader.* Duke was first used as a title in England in 1337, when Edward III gave his eldest son the title *Duke of Cornwall.* A woman who holds a dukedom or is the wife of a duke is called a *duchess.*

**Marquess** is the second highest title in the peerage. The word *marquess* (often spelt *marquis*) comes from the Latin word *marchensis,* a prefect of the *marches* (border districts). The first marquessate created in the English peerage was that of Dublin. Richard II granted it to Robert de Vere in 1385. A woman who holds a marquessate or is the wife of a marquess is called a *marchioness.* The holder of a marquessate or lower peerage can be referred to in speech or informal writing as *Lord,* as in *Lord Reading.* The wife of a marquess, or a peeress in her own right, can be referred to as *Lady,* as in *Lady Reading.*

**Earl** is the third highest title in the peerage. *Earl* is an Old English word that came from the Norse word *jarl,* meaning a *great man* or a *nobleman.* The first earls in England were the great Saxon and Danish nobles who ruled large areas. A woman who holds an earldom or is the wife of an earl is a *countess.*

**Viscount** is the fourth highest title in the peerage. The word *viscount* comes from the Latin word *vicecomes,* meaning *one who is in place of a count.* The first viscount in England was John Beaumont, who received the title in 1440. A woman who holds a viscounty or is the wife of a viscount is a *viscountess.*

**Baron** is the lowest title in the peerage. The word *baron* comes from the Old French word *barun,* meaning *king's man.* A woman who holds a barony or is the wife of a baron is called a *baroness.* A baron and his wife or widow are almost invariably referred to as *Lord* and *Lady.* But a baroness in her own right is usually called *Baroness.*

### Life peers

A life peerage is granted for the life of the holder only. It may be awarded to a man or a woman. A life peer sits in the House of Lords. Life peers or peeresses have the title baron or baroness.

Some judges are made life peers so that they can sit in the House of Lords to deal with the appeals that the House hears as a court of law. They are known as *Lords of Appeal in Ordinary.*

### Peeresses

Some women hold peerages in their own right and are entitled to sit in the House of Lords. One group of peeresses holds ancient peerages that were created by *Writ of Summons.* Such peerages can pass to the eldest daughter if the holder leaves no male heir. English peerages pass into *abeyance* if there is more than one daughter. That is, the title is not awarded until a decision is made, usually by the Crown, about who shall have it. Other peeresses are specifically allowed to inherit peerages. If a peerage is conferred on a man who has no son, a *special remainder* may be added to his letters patent to allow the peerage to pass to a daughter. A third group of peeresses holds life peerages.

### The right to disclaim

Any person who succeeds to a hereditary peerage may *disclaim* (renounce) the title for his or her own lifetime. On the person's death, the title is revived and passes to the heir, who may accept it or disclaim it.

A peer who wishes to disclaim a title must do so within 12 months of succeeding to it or attaining the age of 21. If a person is a member of Parliament, he or she must disclaim within a month to remain an MP. Once a peer has disclaimed a title, he or she cannot be given another hereditary title.

### Courtesy titles

All dukes, marquesses, and earls possess titles in addition to those by which they are known. By tradition, the eldest son of one of these peers uses the most senior of his father's subsidiary titles as a *courtesy title.* This title must be at least one degree lower than his father's

peerage. The courtesy title must also be of a different place from that of the senior peerage. For example, the Duke of Bedford also holds the titles Marquess of Tavistock, Earl of Bedford, Baron Russell (of Chenies), Baron Russell of Thornhaugh, and Baron Howland of Streatham. His eldest son uses the courtesy title Marquess of Tavistock.

Younger sons of dukes and marquesses use the courtesy style of *Lord* with their given names. *Lord John Smith* would be the son of a duke or marquess. Daughters of dukes, marquesses, and earls use the style of *Lady* with their given names, as in *Lady Mary Smith.* Younger sons of earls and all children of viscounts and barons are called *The Honourable,* as in *The Hon. John* or *The Hon. Mary Smith.*

### History

England has had a nobility since Saxon times. The House of Lords evolved from the *Curia Regis* (king's council) of William I. Richard II created the first peerage by letters patent in 1387, when he gave John Beauchamp the title of Baron Beauchamp of Kidderminster.

The peers of the Middle Ages had great power. They owned land, were wealthy, and had many *retainers* (followers). Henry VII destroyed most of the power of the great peers.

The Act of Union that united England and Scotland in 1707 provided that the Scottish peers should elect 16 lords to sit in the House of Lords as *representative peers* for Scotland. The Act of Union of 1801, which united Great Britain and Ireland, provided that the Irish peers should elect 28 lords to sit in the House of Lords for life.

The Peerage Act of 1963 allowed all Scottish peers to sit in the House of Lords. Elections of Irish peers ceased after the formation of the Irish Free State (now the Republic of Ireland) in 1922.

The first life peerages were created under the Appellate Jurisdiction Act of 1876, which gave the sovereign power to make judges life peers so that they could hear appeals in the House of Lords. In 1958, Parliament passed the Life Peerages Act, which enables the sovereign to give life peerages.

The Peerage Act of 1963 gives people who inherit peerages the right to renounce them for life. Its main purpose is to give peers a chance to be eligible for membership of the House of Commons.

Many present-day peerages were created hundreds of years ago and have descended in an unbroken line ever since. The oldest titles in England are: *dukedom,* Norfolk, created 1483; *marquessate,* Winchester, 1551; *earldom,* Shrewsbury, 1442; *viscounty,* Hereford, 1550; and *barony,* de Ros, 1264. The Scottish Earldom of Mar is so old, it cannot be dated.

**Peerage.** See Nobility.

**Peerce, Jan** (1904-1984), became one of the most successful American opera and concert tenors of his day. His faultless musicianship won praise from Arturo Toscanini and other leading conductors. Peerce was the tenor in several of the famous Toscanini-National Broadcasting Company opera radio broadcasts. The broadcasts were later transferred to commercial recordings on disc. Peerce's excellent though not spectacular voice retained its power even when he was more than 60 years old.

Peerce was born in New York City. His real name was Jacob Pincus Perelmuth. Peerce played the violin in dance orchestras before he became a tenor at Radio City Music Hall in New York City in 1933. He made his operatic debut in 1938 in Philadelphia as the duke in Giuseppe Verdi's *Rigoletto.* Peerce appeared in a New York recital in 1939, and made his debut with the Metropolitan Opera in 1941 as Alfredo in Verdi's *La Traviata.*

**Peewit.** See Lapwing.

**Pegasus** was an immortal winged horse in Greek mythology. He was the offspring of Medusa, a monstrous, snake-haired woman, and Poseidon, god of horses and of the sea. The hero Perseus slew Medusa by cutting off her head. Pegasus sprang full-grown either from her head or neck, or from the blood from her neck.

The hero Bellerophon wanted to tame Pegasus. A prophet advised him to sleep on the altar of the goddess Athena. There, Bellerophon dreamed that the goddess gave him a golden bridle and ordered him to make a sacrifice to Poseidon. When he awoke, Bellerophon found a bridle on the altar. He sacrificed a bull to Poseidon and later came upon Pegasus at a spring, waiting to be bridled.

Bellerophon rode Pegasus on many adventures. Their most famous feat was destroying the fire-breathing Chimera (see **Chimera**). Bellerophon attempted to ride Pegasus up to Mount Olympus, the heavenly home of the gods. Zeus, king of the gods, was angered by the mortal's presumption in attempting to reach the heavens. Zeus sent a gadfly to sting Pegasus. The horse bucked, throwing Bellerophon down to earth and permanently crippling him. Pegasus arrived on Olympus without a

Detail from painting by Andrea Mantegna (late 1400's); The Louvre, Paris

**Pegasus, the winged horse,** appears in Greek mythology. It is shown here with Mercury, the messenger of the gods.

rider. The horse remained there, carrying Zeus's lightning and thunderbolts.

See also Medusa.

**Pegmatite.** See Beryl; Feldspar.

**Pehm, Joseph.** See Mindszenty, Joseph Cardinal.

**Pei, I. M.** (1917- ), is an American architect noted for his creative urban designs. These designs include skyscrapers, housing projects, museums, and academic and government buildings. Pei has designed structures in a number of styles, but many of his buildings have broad, irregular geometric shapes.

Ieoh Ming Pei was born in Guangzhou (also called Canton), China, and travelled to the United States in 1935

**Pei's John F. Kennedy Library** in Boston, U.S.A. is built of white concrete and glass. The nine-storey structure emphasizes the geometric shapes that are typical of Pei's designs.

to study architecture. He became a U.S. citizen in 1954. Pei's early works show the influence of the modern German architects Walter Gropius and Ludwig Mies van der Rohe. These works include the Mile High Center (1955) in Denver, Colorado, and the Society Hill housing project (1964) in Philadelphia.

In the late 1960's, Pei began to develop a more personal style. His later projects include the National Center for Atmospheric Research (1967) in Boulder, Colorado; the East Building (1978) of the National Gallery of Art in Washington, D.C.; and the John F. Kennedy Library (1979) in Boston, Massachusetts. In 1989, Pei completed a glass pyramid situated in front of the Louvre museum in Paris (see Louvre [picture]). Pei has also designed buildings in other countries, including his native China.

**Peiping.** See Beijing.

**Peipus, Lake.** See Lake Peipus.

**Peirce, Charles Sanders** (1839-1914), was an American philosopher. He helped lead a philosophical movement called *pragmatism.* Peirce pioneered in developing mathematical logic. He also helped develop *semiotics,* the study of the use of signs and symbols, including words.

Peirce discussed the basic ideas of his pragmatism in an essay called "How to Make Our Ideas Clear" (1878). To understand an idea, he declared, we must consider the behaviour of objects to which the idea refers. For example, if we say that a diamond is "hard," we should want to know what this idea means. Therefore, we should find out what a diamond can do—such as scratch a piece of glass without being scratched itself. We understand what we mean by a diamond if we know what it does do, could do, and might do under various circumstances. The meaning of an object, according to Peirce, also includes how we are likely to behave in its presence.

Like other pragmatists, Peirce wanted to connect thought and action. He believed that our thoughts should produce beliefs upon which we can act confidently. If we are in doubt, we hesitate. Doubt forces us to inquire into things until we have a belief. If we are not able to clear up our doubts with further inquiry, we must act on the belief that is most likely to be true.

Peirce was born in Cambridge, Massachusetts, U.S.A. His father, the famous mathematician Benjamin Peirce, introduced him to the study of science and philosophy. Peirce graduated from Harvard University in 1859 and did scientific work for the United States Coast Survey from 1861 to 1891. These scientific studies stimulated his interest in philosophy. During his career, Charles Peirce also expressed original ideas about evolution, the role of chance in the universe, the human mind, and the reality of God.

Peirce did not present his philosophy in any organized fashion, and so he received little recognition during his lifetime. Years after his death, however, several philosophers published Peirce's works in eight volumes called *The Collected Papers of Charles Sanders Peirce.*

See also Pragmatism.

**Peking.** See Beijing.

**Peking man** was a type of prehistoric human being who lived between about 500,000 and 250,000 years ago in what is now northern China. Scientists named this creature *Sinanthropus pekinensis,* which means *Chinese person of Peking.* Peking man belonged to a species of early human beings called *Homo erectus* (erect human being).

In the 1920's, Davidson Black, a Canadian anatomy professor, identified fossils found near Beijing (also spelled Peking), China, as remains of prehistoric human beings. Since then, scientists have found the partial remains of more than 30 of these prehistoric people, along with more than 100,000 stone tools and countless animal bones, mainly those of deer. The fossils show that Peking man stood about 155 centimetres tall and had heavy bones. These people apparently had big brow ridges, powerful jaws, large teeth, and a brain smaller than that of modern people.

In 1941, most of the fossils disappeared while being shipped out of China. In 1963 and 1964, scientists found similar fossils at Lantian about 970 kilometres southwest of Beijing.

See also Prehistoric people (picture: Early primitive human beings [*Homo erectus*]).

**Pekingese,** also spelled *pekinese,* is a small dog with long hair, a broad flat face, and a tail that curls over its back. The Pekingese has short legs, a long body, and a large head with long-fringed ears. Its front legs are bowed, and its tail is plumed. Its eyes are quite prominent. When the Pekingese trots, it sways from side to side. It may be almost any colour, but is usually tan or brown with light shadings. In size, it stands 30 to 45 centimetres high at the shoulder and weighs 3.6 to 4.5 kilograms. One kind of Pekingese, the *sleeve Pekingese,* was so named because ladies of the Chinese court carried the dogs in their balloonlike sleeves.

The Pekingese was the royal dog of China, and at one time only people of royal blood could own the dog. It has been raised in China since the 700's, but the rest of the world did not know of the dog until 1860, when the British Army seized Beijing (also spelled Peking) and Admiral Lord Hayes took two Pekingese to England. The Pekingese is a mischievous, intelligent animal. In spite of its small size, it is bold and brave.

See also **Dog** (picture: Toy dogs); **Shih Tzu.**

**Pelé** (1940-        ), a Brazilian footballer, won fame as the greatest soccer player of his time and the most recognized athlete in world sports. A forward, Pelé electrified crowds with his daring dribbling, perfect passing, and accurate shooting. He holds every major scoring record in Brazil, and scored 1,281 goals in 1,363 games during his professional career. Pelé is the only professional soccer player to score 1,000 goals in a career.

Pelé was born in Três Coracões, Brazil. His real name is Edson Arantes do Nascimento. Pelé joined the Santos (Brazil) Football Club in 1956 and led Santos to world club titles in 1962 and 1963. He is the only soccer player to have played in three world championship teams, leading the Brazilian national team to World Cup championships in 1958, 1962, and 1970. Pelé retired as a player in 1974 but returned to competition in 1975 with the New York Cosmos of the North American Soccer League (N.A.S.L.). Pelé retired again after leading the Cosmos to the N.A.S.L. championship in 1977.

**Pelée, Mont.** See **Mont Pelée.**

**Peleliu** is a narrow raised reef island in the Western Pacific. It is in the Palau group of the western Caroline Islands, about 970 kilometres east of the Philippines. It covers about 13 square kilometres. About 610 people live on the island. Both Germany, which owned it from about 1899 until World War I, and Japan, which held it under a League of Nations mandate until World War II, mined phosphate there.

The Japanese used Peleliu as a military base, and dug caves in the soft coral rock for use in defence. U.S. Marines landed on Peleliu on Sept. 15, 1944. Organized resistance on Peleliu ended by November 25, but the last soldiers did not surrender until February 1945. In 1947, Peleliu became part of the Trust Territory of the Pacific Islands, which was administered by the United States. In 1994, Palau, of which Peleliu forms a part, became an independent country and the Trust Territory ceased to exist.

**Peleus.** See **Achilles.**

**Pelham, Henry** (1695-1754), was Britain's prime minister and chancellor of the Exchequer from 1743 until his death. In 1751, his government passed an act restricting the sale of gin. In 1753, the Marriage Act was passed, which specified that no marriage would be legal unless it had been performed after the calling of *banns* (public announcement of the marriage), and in a building of the Church of England. Pelham was succeeded by his older brother, the Duke of Newcastle.

**Pellas.** See **Jason; Medea.**

**Pelican** is a large bird that lives near water. Pelicans have a long, straight bill with a flexible pouch made of skin on the underside. They use the pouch to catch fish, their chief food. Pelicans have webbed feet and are strong swimmers. They also are skilled fliers, but they are clumsy on land.

**Kinds.** There are seven species of pelicans worldwide. Five of these species have white feathers with some black on the wings. Of the remaining two species, one is grey and white, and the other is brown. The brown species, called the *brown pelican,* lives along the coasts of North and South America. The six other species inhabit rivers and shallow lakes in Africa, Asia, Australia, Europe, and North America.

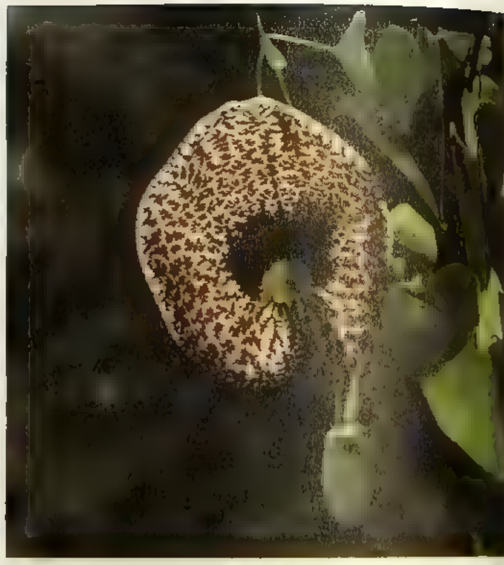
The *Australian pelican* is the largest species, and grows to about 1.8 metres long. It has a wingspan of over 2.5 metres and weighs up to 15 kilograms. The brown pelican is the smallest species, about 1.2 metres long and with a wingspan of 2 metres.

**Habits.** White pelicans often fish in groups. They swim along the top of the water in a line, driving the fish ahead of them. After the fish have been chased into shallow water, the pelicans scoop up the catch with their pouches. The brown pelican uses a different method to capture fish. It flies until it spots a fish near the surface of the water. Then it dives into the water to catch the fish. The brown pelican has especially large air sacs that give it great buoyancy. When it dives, it seldom goes completely below the water.

Pelicans are almost always seen in flocks. While flying, American white pelicans may gather in flocks of up to 1,000 birds. These birds may soar upward in tight cir-

**The Australian pelican,** the largest species of pelican, grows up to 1.8 metres long. It lives mainly by lakes and rivers.

**Dalmatian pelicans** nest in loose colonies either in exposed areas, *above,* or in dense aquatic vegetation.



**The pelican flower plant** is a woody vine. The edges of the flower are flared and have purplish markings.

cles on a rising current of hot air called a *thermal.*

Pelicans nest in large *colonies* (groups). The brown pelican, *pink-backed pelican,* and *spot-billed pelican* nest in trees. They build their nests out of twigs and other plant materials. White pelicans nest in small hollows on the ground, usually on islands. Female pelicans lay from one to four chalky-white eggs, which hatch in about a month. Pelicans are born without feathers. Adult pelicans feed their young by passing partly digested food back into their pouch.

**Endangered pelicans.** Pelicans are sensitive to disturbance and their numbers have been reduced in many areas by their feeding grounds being polluted, and their nesting grounds destroyed. Two of the most seriously endangered species are the *Dalmatian pelican* of Europe and Asia and the spot-billed pelican of India and Sri Lanka.

**Scientific classification.** Pelicans belong to the family Pelecanidae. The brown pelican is *Pelecanus occidentalis,* the Australian pelican is *P. conspicillatus,* the American white pelican is *P. erythrorhynchos,* the pink-backed pelican is *P. rufescens,* the spot-billed pelican is *P. philippensis,* and the Dalmatian pelican is *P. crispus.*

**Pelican flower** is a flowering woody vine from Central America. The flower may be 45 centimetres wide. It is made up of a large greenish-yellow tube that starts downward, then bends up and out. The edges flare out in the shape of a shield that has purple veins and spots. The shield ends in a long "tail" that may extend 90 centimetres or more. The flower bud resembles a pelican. The root is used to relieve snake bite. An infusion of the leaves is used as a remedy against colds and chills.

**Scientific classification.** The pelican flower is in the birthwort family, Aristolochiaceae. It is *Aristolochia grandiflora.*

**Pelion** is a mountain in Thessaly in Greece. In ancient times, it was thought to be the home of the centaur Chiron who lived in a cave near its top. The ship *Argo* was built from trees that grew on its sides. Pelion lies between Vólos and the east coast, and rises 1,617 metres above the sea. According to Greek mythology, the Giants took Pelion and piled it on top of another mountain named Ossa. They were trying to climb to Olympus, home of the gods. See also **Argonauts; Centaur.**

**Pella** is a small town in northern Greece, lying almost 39 kilometres northwest of Salonika (Thessaloniki). In ancient times, it occupied an area of gently rising ground overlooking a lake formed by the Lydias River. Ships could sail up the Lydias from what is now the Gulf of Salonika as far as Pella, which became a significant port. In about 400 B.C., Archelaus, king of Macedonia (reigned 413-399 B.C.), moved his capital from Aigai to Pella. Philip II and his son Alexander the Great were both born in Pella, and it continued to be the Macedonian capital until the Romans captured it in 167 B.C. After 146 B.C., it was eclipsed in importance by the nearby town of Thessaloniki (site of the modern Salonika).

See also **Philip II, Alexander the Great.**

**Pellagra** is a disease caused by a lack of niacin and other B-complex vitamins (see **Vitamin** [Vitamin B complex]). This disease became widespread after the Spaniards introduced maize into Europe from Central America in the early 1700's. Maize is a poor source of niacin, and many people who ate maize as the main part of their diets developed pellagra. Today, it occurs chiefly in developing nations where maize and maize products are the major food sources. It also may affect people who do not maintain a proper diet, especially of poor people and people dependent on alcohol or drugs.

Early symptoms of pellagra include weakness, lack of appetite, diarrhoea, and indigestion. *Dermatitis* (skin inflammation) develops, especially on parts of the body exposed to sunlight, heat, friction, or other irritants. The tongue becomes swollen and sore, and *lesions* (skin eruptions) develop in and around the mouth. Later symptoms of pellagra include anxiety, headaches, irrita-

bility, and sleeplessness. In extreme cases, severe *psychosis* (mental illness) may develop.

Pellagra is treated by changing the diet so that it includes a sufficient amount of protein-rich foods, such as meat, fish, eggs, and milk and milk products. In some cases, doctors prescribe niacin tablets for patients with pellagra.

**Pellegrina, La.** See Gem (Some famous gems).

**Pelopidas** was a general and statesman in ancient Thebes during the 300's B.C. In 382 B.C., the Spartans seized Thebes, and Pelopidas fled. Returning in 379 B.C., he drove the Spartans out and freed his homeland. With the aid of Epaminondas, another general, he trained the Thebans in military discipline and strategy. They formed a special group of 300 soldiers known as the *Sacred Band.* The two Theban generals defeated Sparta in the Battle of Leuctra in 371 B.C., and Thebes became the most powerful state in Greece. Pelopidas used his power to support democratic governments in other Greek cities. In 364 B.C., he was killed in battle. Epaminondas died in war two years later, and the Theban supremacy collapsed.

**Peloponnesian War** was fought by the ancient Greek city-states of Athens and Sparta from 431 to 404 B.C. According to Thucydides, a Greek historian who lived during the war, the Peloponnesian League, consisting of Sparta and its allies, attacked the Athenian empire because it feared the growing power of Athens.

The war was divided into three parts: (1) *The Archidamian War* (431-421 B.C.) was named after Archidamus, the Spartan king who led annual attacks on Athens. Archidamus hoped to force the Athenians to surrender, but the Athenian navy successfully defended the city, which was also protected by walls. (2) *The Peace of Nicias* (421-413 B.C.) was arranged by Nicias, an Athenian politician. The peace was broken when Athenian commander Alcibiades persuaded Athens to attack the Peloponnesian League in 418 B.C. and Sicily in 415 B.C. Both attacks failed. (3) *The Decelean or Ionian War* (413-404 B.C.) ended in victory for Sparta. Sparta gained the support of Persia, helped subjects of Athens revolt, and forced Athens to surrender.

See also **Alcibiades; Athens; Pericles; Sparta.**

**Peloponnesus** is the ancient name of the southern peninsula of Greece. In medieval times, it was known as Morea, and it is sometimes still called by that name. Ancient Peloponnesus was divided into six districts: Messenia, Argolis, Laconia, Elis, Arcadia, and Achaea.

See also **Achaeans; Arcadia; Messenia; Greece** (The Peloponnesus).

**Pelota,** also known as *jai alai,* is a fast and dangerous game that resembles handball. Players use a narrow wicker basket to throw a hard ball against the front wall of a court. The basket, called a *cesta,* measures about 60 centimetres long. One end has a glove that fits the player's hand. The other end is used for catching and throwing the ball. The ball, also called a *pelota,* is about 5 centimetres in diameter and weighs about 130 grams.

Pelota is played on a walled court called a *cancha.* The court has three walls and is about 54 metres long, 17 metres wide, and 12 metres high. Spectators sit along the open side of the court, watching the game through a protective screen. A side may consist of one, two, or three players. Spectators often bet on the games.

**Pelota** is often called the fastest game in the world. It requires much speed, physical energy, and strength. This ancient Basque sport is played with a basketlike *cesta* and a ball.

To begin a singles game, the server hurls the ball from his cesta against the front wall. The opponent must catch the ball either before it hits the floor or on the first bounce. The opponent then hurls the ball against the wall, and the server must catch it and throw it back. The ball often travels at about 240 kilometres an hour and can injure or even kill a player. If the opponent misses the ball, the server scores a point. If the server misses, the opponent wins the serve. Points can be scored only by the player who is serving. Seven-point and nine-point games are popular for betting. In international doubles games, called *partido* games, a team must score 30 or 40 points to win.

**Pelsaert, François,** was a Dutch navigator who charted part of the western coast of the Australian continent in 1629. His ship, *Batavia,* ran aground on the Houtman Abrolhos Islands, off the western coast. Pelsaert took some of his crew in a small boat, and headed for Batavia, more than 3,200 kilometres away. During his journey, he sailed about 805 kilometres up the mainland coast. In his absence, some of the crew mutinied and murdered more than 100 men and women. Pelsaert later returned to rescue the survivors and salvage much of the ship's rich cargo.

**Pelt.** See Fur (with pictures).

**Pelton wheel.** See Turbine (Water turbines; pictures).

**Pelvic inflammatory disease,** often referred to as *PID,* is an infection of the female reproductive system. It affects a woman's uterus and fallopian tubes, both of which are located in the pelvic cavity. PID is caused by several bacteria, particularly the ones that cause gonorrhoea and chlamydia. In most cases, the bacteria enter a woman's body during sexual intercourse with an infected male. If untreated, the disease can lead to infertility and, in rare cases, death.

Many patients with acute PID experience symptoms during or shortly after their menstrual period. Symptoms include lower abdominal pain; vaginal discharge; fever; and nausea. Patients notice tenderness of the uterus, fallopian tubes, and ovaries; upon examination by a doctor. In severe cases, patients may have an *ab-*

*scess* (collection of pus) in the infected area. If the abscess ruptures, a large amount of bacteria may be released into the bloodstream and cause death. PID also is a primary risk factor for *ectopic,* or *tubal, pregnancy,* a potentially fatal condition in which a fertilized egg starts developing in a fallopian tube instead of in the uterus.

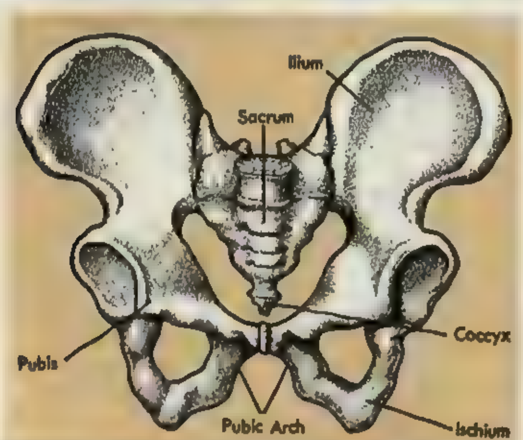
Women with mild cases of PID can be treated with antibiotics as outpatients. Those with severe PID should be hospitalized and given antibiotics intravenously. Patients with an abscess may need surgery.

See also **Chlamydia; Gonorrhoea.**

**Pelvis** is the framework of bones that supports the lower part of the abdomen. It surrounds the urinary bladder, the last portion of the large intestine, and, in women, the reproductive organs. A female's pelvis is flatter and broader than a male's, and it has a larger central cavity.

The spinal column joins the pelvis at the *sacroiliac joints.* The *femurs* (thigh bones) join the lower part of the pelvis in large ball-and-socket hip joints that allow the legs to move in many directions. Many large muscle masses lead from the pelvis to the femurs.

Two big, symmetrical hipbones form the pelvis. These bones join in front to form the *pubic symphysis.* At the back, they form a strong union with the *sacrum* (five backbones joined to form a single bone). Each hipbone in an adult appears to be one solid bone. But it is




**The bones of the pelvis form a basinlike structure.**

formed by three bones, the *ilium, ischium,* and *pubis,* that unite as the body matures. The ilium is the broad, flat bone you feel when you rest your hand on the hip. When you sit down, much of your weight rests on the ischium. The pubis bones form two arches in front that join at the symphysis.

**Pembroke Welsh corgi** is a breed of dog that originated in the area of Pembroke, Wales, during the early 1100's. The Celtic people used these dogs to drive cattle and for other farm work.

Pembroke Welsh corgis are the smallest of the group of breeds called *herding dogs.* They stand from 25 to 30 centimetres high and weigh from 8 to 13 kilograms. Pembrokes have short, thick coats that protect them from all kinds of weather. Most are yellowish- or reddish-brown and may have white patches on the head, neck, chest, and legs. Some have black-and-tan coats. Pembrokes are considered highly intelligent, and they make affectionate pets.

The Pembroke Welsh corgi closely resembles the Cardigan Welsh corgi. However, the Pembroke has a slightly shorter body and a finer-textured coat.

See also **Cardigan Welsh corgi; Dog** (picture: Herding dogs).

**Pemmican** was one of the first forms of concentrated food. North American Indians made it from dried buffalo or deer meat. The Indians often hung the meat at the top of a *tepee* (tent) to dry over a campfire, which gave the meat a smoky flavour. They pounded the dried meat into a powder and mixed it with hot fat. When this mixture cooled, it was cut into cakes. Sometimes berries were added for flavour. Pemmican served as the main food when the tribes migrated. Pemmican keeps almost indefinitely and takes up little room.

Today, explorers, surveyors, hunters, and others often take pemmican with them on long trips. Pemmican is now usually made of beef. The people of South America make *tasajo,* which is much like pemmican, as is the *biltong* of South Africa.

**Pen** is an instrument used for writing or drawing with ink. Pens of one type or another have been used for thousands of years. Today, pens are among the most widely used writing instruments.

There are five main kinds of pens. They are (1) ballpoint pens, (2) fountain pens, (3) soft-tip pens, (4) rolling-ball pens, and (5) speciality pens.

**Ballpoint pens** have a tiny ball made of brass, steel, or tungsten carbide as their writing tip. A compartment called the *ink reservoir* holds the ink, and a narrow tube links the reservoir to the ball. The ball, which is fitted into a socket, turns as it rolls across the paper, carrying ink from inside the pen onto the paper.

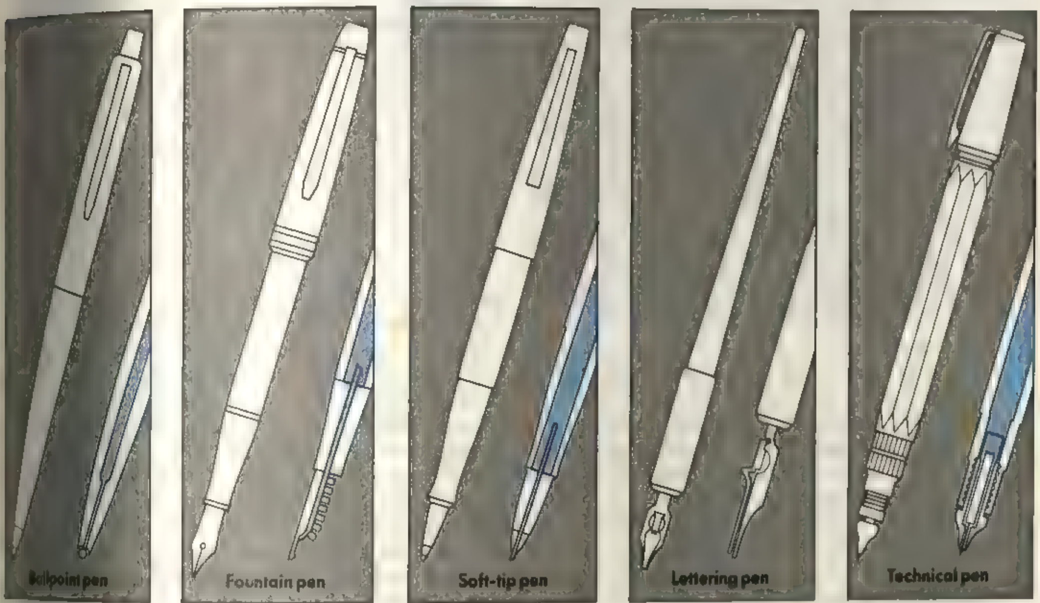
Most ballpoint pens depend on gravity to pull the ink to the ball. For this reason, ballpoint pens generally do not write well when held sideways. However, some ballpoints are designed so that slight pressure is always applied behind the ink column. This design enables the ink to move constantly forward and the pen to write even when its point is higher than its back end.

**Fountain pens** have a somewhat triangular writing point, called a *nib,* which is made of gold or stainless steel. A system of narrow tubes known as the *feed* carries the ink from the pen's reservoir to the nib. In many fountain pens, the reservoir is a replaceable ink cartridge. In others, the user can refill the reservoir from a separate supply of ink.

Fountain pens use a highly fluid ink. They rely on a property called *capillarity* to draw the ink into and through the feed. Capillarity causes the inner surface of the tubes to attract molecules of ink. These ink molecules, in turn, attract other ink molecules, and the feed fills with ink from the pen's reservoir. See **Capillarity.**

The feed in a fountain pen also includes a number of air passages that lead to the reservoir. These passages allow air to fill the top of the reservoir as ink is drawn from the bottom. If the air pressure inside the ink reservoir is lower than the atmospheric pressure outside, the ink will not reach the point and the pen will fail to write. However, if the air pressure over the ink column

**Some kinds of pens** Pens are used for writing and drawing with ink. Pens differ in several ways, including the type of writing tips they have and the ink they use. Some common pens are shown below.




becomes greater than the air pressure outside the pen, ink will flood out from the front of the pen. To avoid such flooding, fountain pens are designed with a *collector.* The collector, which is located near the nib, consists of a series of fins and spaces that provide enough additional room to accommodate forward-moving ink.

**Soft-tip pens,** also called *porous-pointed pens,* have a relatively soft writing tip. Some soft-tip pens, called *felt-tip pens,* have a feltlike writing tip. The tip of others is made of absorbent plastic.

Soft-tip pens use fluid, brilliantly coloured inks. The reservoir in a soft-tip pen consists of a special synthetic material made up of many fibres. This type of reservoir, called a *capillary reservoir,* holds ink in much the same way that a sponge holds water. During writing, the absorbent tip of a soft-tip pen continually draws ink from the reservoir onto the paper.

**Rolling-ball pens** combine certain features of ballpoint, fountain, and soft-tip pens. Like ballpoint pens, rolling-ball pens have a tiny ball that turns in a socket at their tip. But unlike ballpoints, rolling-ball pens use highly fluid inks, which allow them to write as smoothly as soft-tip and fountain pens.

Rolling-ball pens may have either a capillary reservoir similar to that used in soft-tip pens or a reservoir like that of ballpoints. A wick made of an absorbent material draws ink from the reservoir and carries it to the ball. The wick can carry only a limited amount of ink at any one time. In this way, the wick regulates the flow of ink and prevents it from leaking out.

**Speciality pens** are designed for specific purposes. For example, artists and technical draughtsmen use a pen called a *technical pen.* This pen comes with a set of interchangeable pen points of varying widths. Another special pen, called a *lettering pen,* is used to create an elegant style of handwriting called *calligraphy.*

**History.** As early as 4,000 B.C., ancient peoples used crude pens consisting of hollow straws or reeds that supported a short column of liquid. During the 500's B.C., people began to make pens from the wing feathers of such birds as geese and swans. The shaft of the feathers was hardened, and the writing tip was shaped and slit to make writing easy. These feather pens were known as *quill pens,* and they were widely used until the development of steel-nib pens in the 1800's.

By the late 1800's, inventors had perfected an early version of the fountain pen. This pen represented a major improvement over previous pens, because it featured an ink reservoir and a capillary feed. Earlier pens held only a small amount of ink at a time and had to be repeatedly dipped in ink.

Lazlo Biro, a Hungarian, patented the first commercially successful ballpoint pen. During World War II (1939-1945), many pilots began using Biros, because such pens did not leak at high altitudes. After the war, Biros became increasingly popular. Soft-tip pens and rolling-ball pens both were introduced during the 1960's.

**Pen name** is a name an author uses instead of his or her real name. Pen names are also called *pseudonyms.* Thousands of authors use pen names. Most are popular novelists who adopt one or more pen names to avoid flooding the market with many works published under the same name. Writers sometimes use pen names to conceal their identity for legal reasons, to protect their privacy, or because they are dealing with highly personal or controversial material. During the 1800's, many women writers adopted masculine pen names because of sexual discrimination against female authors.

Pen names first became common in the 1700's with the emergence of newspapers, magazines, and other periodicals. Authors adopted pen names because they

feared political persecution for their writings. Perhaps the most famous early pen name was Voltaire, which was adopted in 1718 by the French writer François Marie Arouet. The English writer Charles Dodgson wrote under the pen name of Lewis Carroll. The American author Samuel Clemens used the pen name Mark Twain. The children's writer Theodor Seuss Geisel uses the pen name Dr. Seuss. John Creasey, an English mystery writer, used 27 pen names.

See also **Name** (Pseudonyms).

**Penal colony** is a settlement outside a country where the country sends its prisoners. From the 1500's to the mid-1900's, many European nations operated penal colonies to help relieve overcrowded prisons and to remove convicts to faraway places. Countries sometimes used the prisoners as labourers to develop the natural resources of a colony.

Great Britain sent many prisoners to the American Colonies in spite of the objections of colonists there. The American Revolution (1775-1783) ended penal colonies in America. The British then shipped criminals to Australia. These prisoners were the first white people to settle in Australia (see **Australia** [History]).

A well-known French penal colony was Devil's Island in French Guiana. This colony was started by Napoleon III in 1852. In 1945, the prisoners at Devil's Island were transferred or liberated.

In the past, penal colonies were known for their brutal treatment of prisoners. The prisoners were often chained together and whipped. Today, conditions have improved, but most of the remaining penal colonies are still places of harsh punishment.

**Penance.** See **Roman Catholic Church** (The seven sacraments).

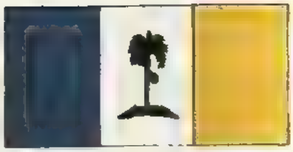
**Penang,** also called *Pulau Pinang,* is a small state on the west coast of Peninsular Malaysia. It consists of the island of Penang and a strip of land on the mainland known as *Province Wellesley* or *Seberang Perai.* The strait between the island and the mainland part of the state varies in width from 3 to 12 kilometres. Province Wellesley has boundaries to the north and east with Kedah and to the south with Perak. A narrow strait to the west divides it from Penang Island. The state capital is George Town. The island takes its name from the Malay word for the betel palm *(pokok pinang).*

## People and government

**People.** About 55 per cent of the population of Penang are Chinese, 33 per cent are Malay, and about 11 per cent are Indian. The high proportion of Chinese is due to immigration from the middle of the 1800's. Many *coolie* (Chinese) immigrants were heading for the tin-mining states of Perak and Selangor, but a large number stayed in, or returned to, Penang to work on the docks and wharves. There was also an important and wealthy Chinese merchant community. The principal Chinese dialect in Penang is Hokkien. There are also large Cantonese, Teochieu, and Hainanese groups.

Penang has more different ethnic groups of people than any other state in Malaysia. Each group has its own customs, traditions, festivals, and religions. There are a large number and variety of places of worship, including mosques, temples, and churches. The ethnic differences can also be seen in food and in styles of traditional dress, as well as in language.

**Government.** The head of state of Penang is a governor appointed by the *yang di-pertuan agong* (paramount ruler). The state legislative assembly has 33 seats. See also **Malaysia, Government of.**




**The Penang flag** features the betelnut tree *(pokok pinang)* from which the island takes its name. The coat of arms, *right,* has a representation of the Penang Bridge.

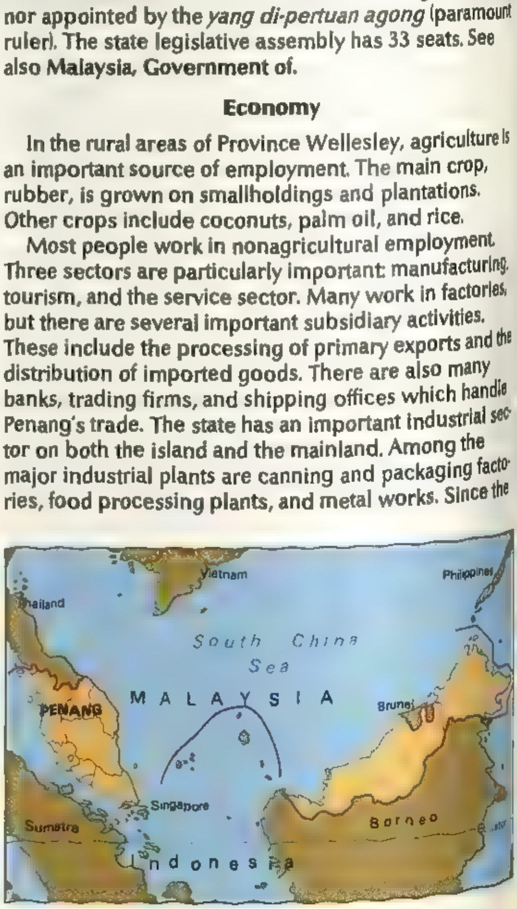
## Economy

In the rural areas of Province Wellesley, agriculture is an important source of employment. The main crop, rubber, is grown on smallholdings and plantations. Other crops include coconuts, palm oil, and rice.

Most people work in nonagricultural employment. Three sectors are particularly important: manufacturing, tourism, and the service sector. Many work in factories, but there are several important subsidiary activities. These include the processing of primary exports and the distribution of imported goods. There are also many banks, trading firms, and shipping offices which handle Penang's trade. The state has an important industrial sector on both the island and the mainland. Among the major industrial plants are canning and packaging factories, food processing plants, and metal works. Since the

### Facts in brief about Penang

**Population:** *1991 census*—1,065,075.
**Area:** 1,031 km². (Penang Island 293 km², Province Wellesley 738 km².)
**State capital:** George Town.
**Largest cities:** George Town, Butterworth.
**Chief products:** *Agriculture*—palm oil, rice, rubber. *Manufacturing*—electronic and electrical products, garments, and textiles.




**Penang** is a small state on the west coast of Peninsular Malaysia. It is an island and a strip of the mainland.

early 1970's, many high technology factories have opened. Their products include electronic components, electrical appliances, and textiles and clothing. The state and federal governments have assisted by creating industrial estates, clearing and reclaiming land, and laying down roads and power supplies.

Tourism is an important industry in Penang, and has created a great deal of employment. Penang Island is a major destination for both local holidaymakers and international travellers. A rapid growth in the number of luxury hotels on the island, and the expansion of recreation and sport facilities have created many jobs.

## Land

Penang Island is shaped like a rectangle. It is about 24 kilometres from north to south, and 14 kilometres from east to west. Toward the northeast corner of the island is a wedge-shaped cape which projects into the strait between the island and the mainland. The state capital, George Town, is located there. Most of the island's landscape is hilly, with steep slopes where weathering has softened the granite rocks. Some rocks have remained hard enough for use in building or in road foundations. Elsewhere the tropical climate has broken the rock down into a sticky red or yellow clay. In parts of the island, the clay layer is more than 30 metres thick. Only the jungle vegetation binds the soil together, and land clearance causes serious erosion. For this reason, tropical forests still cover substantial parts of Penang Island. There are beaches on the north, west, and south sides of the island.

Province Wellesley forms a small part of the western coastal plain which extends the full length of Peninsular Malaysia. Only Bukit Mertajam, rising steeply about 540 metres, breaks the expanse of the lowland plain. There are extensive coverings of mangrove tree and *nipah* (nipa) palm in the coastal districts. The principal town in Province Wellesley is Butterworth, which stands across the strait from George Town.

**Kek Lok Si Temple,** at Ayer Itam, Penang, is the largest Buddhist temple in Malaysia.

**Penang Hill** has a funicular railway built in 1923. From the top, there are fine views over the island and mainland.

The state has excellent communications both internationally and with the rest of Malaysia. Bayan Lepas airport on Penang island handles both internal and international flights. There is a major port complex embracing George Town on the island and Butterworth on the mainland. The main west coast railway passes through Province Wellesley, to link with Kedah and Thailand to the north, with the major west coast states, and with Singapore to the south. The Penang Bridge connects the island to the mainland road network.

## History

Originally, the island of Penang was part of the Malay sultanate of Kedah. In 1786, the sultan of Kedah gave up Penang to the British East India Company, in order to gain British protection against possible attacks from Siam (Thailand) or Burma to the north. The East India Company therefore gained an important trading post in Southeast Asia with which to challenge Dutch commercial power. The base commanded the northern entrance to the Strait of Malacca. Francis Light, a British trader entrusted with the negotiations with the sultan, took possession of Penang in the name of King George III, in August 1786. In 1800, the sultan of Kedah also leased the district of Province Wellesley to the East India Company.

Penang was the first British possession in Malaya. In 1826, the British combined Penang (together with Province Wellesley) with Melaka and Singapore to form a single administrative unit, the Straits Settlements. The administrative capital was originally at Penang, but moved in 1832 to Singapore.

Trade was the foundation of Penang's prosperity under British rule. Its geographical position gave it command of the trade of the northwest part of the Malay Peninsula, the western seaboard of southern Thailand, and the east coast of Sumatra. Its sheltered harbour, in the passage between the island and the Malay mainland, attracted many vessels, from European clippers and steamships to small native craft. From the middle of the

1800's, Penang became a centre for the collection, processing, and reshipment of local primary commodities, including tin and rubber from the Malay Peninsula, Thailand, and Sumatra. Local Asian traders brought these goods to the port for partial processing and shipment to major industrial markets in Europe or North America. There was also an important trade in the opposite direction. Manufactured goods from the industrial nations, including cotton textiles, were imported in bulk into Penang. The local traders distributed them throughout the inland areas of the state, travelling by river in small sailing boats. Large numbers of Chinese and Indian labourers also immigrated through Penang, bound for the tin mines and rubber plantations of the Malayan mainland. During the 1800's, Penang developed into a major international port and commercial centre with a multinational population. Chinese and Indian labourers worked in the docks, in the warehouses, on the *lighters* (barges), and in the processing plants. Wealthy Chinese and Indian merchants and moneylenders controlled the local distribution network. European trading houses and banks handled the port's international trade. Europeans were the administrative rulers of the island. The centre of government for the Straits Settlements remained in Singapore. In the 1860's, disorder in the Malay states threatened the prosperity of Penang and severely reduced the flow of tin through the port. The British restored order on the mainland in the early 1870's. By the close of the 1800's, Penang had become a largely Malayan port, serving the Malayan interior.

The Japanese occupied Penang between 1942 and 1945. It returned to British rule after the Japanese defeat. The Federation of Malaya emerged in 1948, comprising all the states of the peninsula together with Melaka and Penang. On Aug. 31, 1957, the Federation of Malaya became politically independent.

See also **Malaysia.**

**Penates.** See **Lares and Penates.**

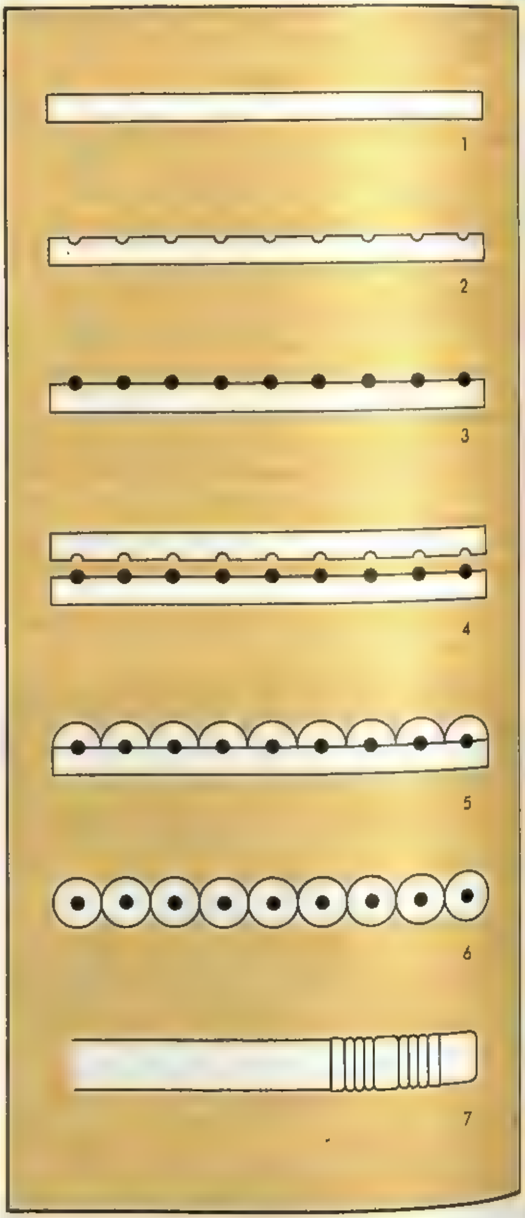
**Pencil** is the most widely used writing and drawing instrument in the world. People use pencils to write words, numbers, music, and poetry, and to draw pictures, plans, maps, and diagrams. There are pencils that write underwater, and pencils used by surgeons to mark their patients' skin before surgery. Astronauts have also taken pencils into space because the writing ability of pencils is unaffected by gravity, pressure, or conditions in the atmosphere. More than 10 billion pencils are produced annually throughout the world.

Pencils consist of a writing core made mostly of graphite set within a case of wood, metal, or plastic. There are three main types of pencils: (1) cased pencils, (2) coloured pencils, and (3) mechanical pencils.

**Cased pencils,** in most instances, consist of a wood case and a black writing core. The core is composed of graphite and fine clay, sometimes combined with wax or other chemicals. When graphite was first used in pencils, people mistakenly thought it contained lead. The graphite mixture is still called *lead* and the pencils, which contain no lead, are often called *lead pencils.*

Graphite for pencils is formed into spaghettilike strings, cut to precise measurements, and dried in ovens. Manufacturers vary the proportions of graphite and clay in the mixture to produce pencils with harder and softer writing cores. The HB (or Number 2) pencil is the standard and most common pencil used today. Pencils identified as B, 2B to 6B (or with numbers less than 2) have increasingly softer leads and contain less clay and more graphite. Soft pencils make a dark, heavy line. Harder pencils make a finer, lighter line.

Most cased pencils are made from incense-cedar. This wood sharpens easily and smoothly and does not warp or lose its shape. Cedar logs that are used to make pencils are sawed into narrow strips called *slats.* The




**Making a cased pencil** involves several steps. First, cedar logs are sawed into narrow slats (figure 1). Parallel grooves are cut into the slats (2). A graphite mixture is laid in the grooves of one slat (3), which is then glued to an empty slat (4). Individual pencils are cut from this pencil "sandwich" (5 and 6). Finally, an eraser is attached to the pencil by a ringlike *ferrule* (7).

slats are about 18.5 centimetres long, 6.2 millimetres thick, and 7 centimetres wide. They are dried, stained, and waxed before shipment to the pencil factory. At the factory, parallel grooves are cut into one side of the slats and half of the slats are then coated with a fine layer of glue. Next the graphite is laid in the grooves of the glued slats, and pencil "sandwiches" are made. Pencil sandwiches are produced by pressing the empty slats onto the slats that already have graphite inserted in them.

The sandwiches then go into a shaper, which forms the slats into individual *hexagonal* (six-sided) or round pencils. Most pencils are manufactured to have a hexagonal shape. The flat sides of such pencils prevent the pencils from rolling off surfaces.

After the individual pencils have been cut from the sandwich, they are painted. Erasers may then be attached to the pencils. Each eraser is surrounded by a round, metal case called a *ferrule*, which is held in place either by glue or by small metal prongs. Most ferrules are made of aluminium or steel.

**Coloured pencils** are made in more than 70 colours. They are produced in much the same way as black-writing pencils, but the cores of these pencils contain such colouring materials as *dyes* and *pigments* instead of graphite.

**Mechanical pencils** have a metal or plastic case. They use leads similar to those used in cased pencils. Mechanical pencils require no sharpening. The lead is forced out of the pointed end by twisting the cap, or by some other mechanical method. The lead rests inside a *spiral* (round coil) within the case and is held in place by a rod that has a *stud* (piece of metal) fastened to it. When the cap is twisted, the rod and stud move downward in the spiral, forcing the lead toward the point.

**History.** The earliest pencils date back to the ancient Greeks and Romans, who used flat cakes of lead to mark faint black lines on *papyrus* (an early form of paper) to guide writers. In the Middle Ages, people used thin rods of lead or silver for drawing. The marking ability of graphite was discovered in the 1500's, and the first modern pencil—that is, one consisting of a wooden case glued around a stick of graphite—was made in the late 1700's.

In 1795, Nicholas Jacques Conte, a French chemist, developed a pencil of powdered graphite and clay. His mixture proved to be as smooth and hard as pure graphite. Conte also discovered that a harder or softer writing core could be produced by varying the proportions of clay and graphite.

In the mid-1800's, William Monroe, an American cabinetmaker, invented a machine that cut and grooved wood slats precisely enough to make pencils. About the same time, American inventor Joseph Dixon developed a machine that smoothed the surfaces of the pencils after the slats were cut apart. In 1861, the first pencil-making factory in the United States was built in New York City by Eberhard Faber, an American manufacturer. The first mechanical pencil was patented by the Eagle Pencil Company in 1879.

See also **Faber, Eberhard; Graphite.**

**Penderecki, Krzysztof** (1933- ), is a Polish composer. Penderecki first gained fame during the 1960's for the originality of his compositions. He became known for incorporating unconventional sounds into his works. For example, in his *String Quartet No. 1* (1960), the musicians slap their instruments and tap them with their bows. In *Dimensions of Time and Silence* (1960), a chorus sings only single-syllable consonants. In other compositions, singers hiss or whistle. His most famous piece is *Threnody for the Victims of Hiroshima* (1960) for 52 string instruments.

Penderecki's religious works include *St. Luke Passion* (1966) and *Utrenja* (1970-1971). For the 25th anniversary of the United Nations, Penderecki wrote *Kosmogonia* (1970) for solo singers, chorus, and orchestra. The work includes quotations from the book of Genesis and from American and Soviet astronauts. Penderecki has composed two operas, *The Devils of Loudun* (1969) and *Paradise Lost* (1978). The latter opera reflects Penderecki's change from a dissonant style toward a more *neoromantic* style. He was born in Dębica.

**Pendle** (pop. 82,700) is a local government district in northeast Lancashire, England. The towns of Nelson and Colne are located in the district, which is important for its long-established textile industries. Other newer industries include aerospace and general engineering, and the manufacture of carpets, felt, furniture, paper, and plastics.

The district has much attractive countryside, including the Forest of Pendle and the Pennine moorlands. Farmers in many parts of Pendle raise sheep and cattle.

See also **Lancashire.**

**Pendleton, George Hunt** (1825-1889), a United States senator, sponsored the Pendleton Act, which created the American civil service system in 1883. A Democrat from Ohio, Pendleton served in the U.S. House of Representatives from 1857 to 1865, and in the U.S. Senate from 1879 to 1885. He was the Democratic party's candidate for vice president in 1864, but he lost the election. From 1885 to 1889, Pendleton served as minister to Germany. He was born in Cincinnati, Ohio, U.S.A.

**Pendulum** is an object that swings back and forth around a fixed point if it is pulled aside and let go. Gravity makes it swing back and forth at a regular rate. The *simple pendulum* consists of a weight hanging at the end of a string or wire. The path travelled by the weight is called the *arc of the pendulum*. The *period of oscillation* is the time it takes the weight to pass back and forth once over this arc.

If a pendulum were taken from one place to another on the earth, the period would change slightly due to a change in the pull of gravity. The period increases if the pendulum is taken from sea level to the top of a mountain, because the force of gravity becomes slightly weaker at greater heights. A simple pendulum 24.87 centimetres long has a period of 1 second at sea level. A pendulum 4 times as long will have a period of 2 seconds. One that is 9 times as long will have a period of 3 seconds, and so on.

The Italian physicist Galileo discovered the laws of the pendulum. He noticed that a hanging lamp would swing with an almost constant period, whether the arc was large or small. He believed that a pendulum could regulate the movements of clocks. The Dutch scientist Christiaan Huygens patented the first pendulum clock in 1657. Galileo's observations are still correct so long as the pendulum's swing is small. But modern measuring

**A Foucault pendulum** shows the rotation of the earth. It swings back and forth in the same plane, but the earth's rotation makes the pendulum appear to change its path gradually.

instruments have shown that the period of a pendulum increases when it has a large swing.

**Clock pendulums** usually consist of a rod with a heavy weight at one end and a hard bearing at the other. A screw at the end of the rod permits the weight, or *bob,* to be raised or lowered. When the bob is lowered, the pendulum swings more slowly, and the clock runs more slowly. When the bob is raised, the pendulum swings faster, and the clock runs faster.

The bearing on which the pendulum swings must be as nearly frictionless as possible. It is often made of a knife edge of agate set in a grooved agate plate.

A device called an *escapement* is fastened to the mechanism of the clock. It gives small but regular pushes to the pendulum and keeps it swinging. The escapement lets one tooth of a toothed-wheel turn past it each time the pendulum swings aside. This action gives the clock its "tick-tock" sound.

The rod in a clock pendulum tends to expand when it is warmed and to shorten when it is cooled. If no correction is made, pendulum clocks will run slower in hot weather and faster in cold weather. Several means have been developed to make up for this effect. For example, clocks known as *regulators* come with so-called *gridiron* pendulums. These pendulums consist of several brass and steel rods. The rods are arranged so that the brass rods raise the bob and the steel rods lower it as the temperature increases. This keeps the total length of the pendulum constant. In another device, the length is kept constant by the expansion and contraction of mercury in a cup that swings at the end of the rod.

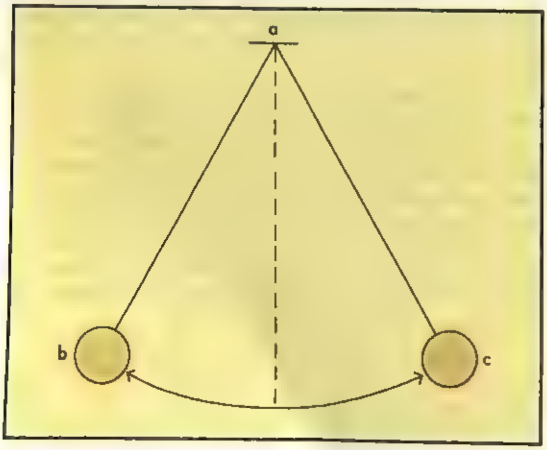
**Other pendulums.** In *torsion pendulums,* a wheel or a balanced set of weights is suspended on a wire. The wire becomes wound into a spring as the weight rotates around it. Torsion pendulums are used in the so-called 400-day clock and in other measuring instruments.

In *bifilar pendulums,* two parallel wires hold the bob. They are pulled tight to provide a more controlled motion. A bifilar pendulum is sensitive to variations of the *plumb line* (line toward the earth's centre of gravity). Bifilar pendulums have been used to show that the earth does not rotate on its axis at a constant speed. The rate of the earth's rotation is affected by the pull of gravity exerted on the earth by the sun and moon.

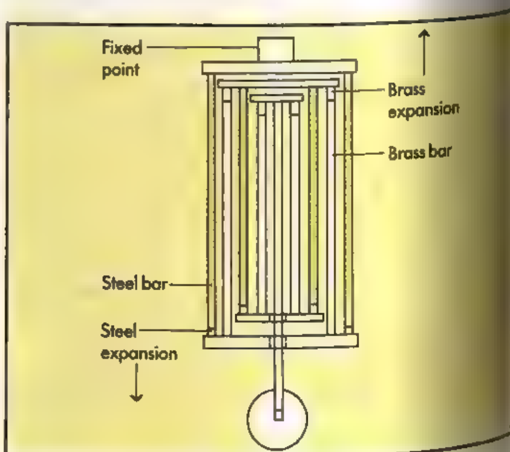
In 1851, the French scientist Jean Foucault hung a large iron ball on a wire about 60 metres long. With this pendulum, he showed that the earth rotates on its axis. The motion of a Foucault pendulum is not limited to a plane. The plane of its swing appears to change as the earth goes through its daily rotation. However, the pendulum actually continues to move in the plane in which it was set in motion, while the earth turns under it. At the equator, a Foucault pendulum does not change its apparent plane of swing. The change would be fastest at the North and South poles (see **Coriolis force**).

One remarkable type of pendulum measures tiny differences in the force of gravity. It is used to detect underground mineral deposits.

See also **Clock; Foucault, Jean B. L.; Galileo; Gravitation; Huygens, Christiaan.**




**A simple pendulum** swings back and forth from a fixed point *a,* and forms an arc between *b* and *c.* The time the pendulum takes to go from *b* to *c* and back to *b* again is called its *period.*




**A gridiron pendulum** has brass and steel rods that expand or contract in opposite directions as temperatures change. The pendulum's length and period are thereby kept constant.

**Penelope,** in Greek mythology, was the wife of Odysseus (Ulysses in Latin), king of Ithaca. She became famous for her faithfulness to her husband. After the birth of their son, Telemachus, Odysseus left on an expedition against Troy. He did not return for 20 years, but Penelope remained faithful to him. Her story is told in the epic poem the *Odyssey.*

Many nobles from Ithaca and neighbouring islands courted Penelope, claiming that Odysseus would never return, but she refused to remarry. For three years, she held suitors off by a trick. She said that she must first weave a shroud for her father-in-law, Laertes. Each night she unravelled what she had woven that day.

After a maidservant revealed Penelope's deception, she promised to select the suitor who could string and shoot Odysseus' great bow. Each suitor tried and failed. A beggar, who had come to the palace and was given shelter, asked to try. He easily strung and shot the bow. The beggar was Odysseus in disguise. With the bow, he killed the suitors. Odysseus regained his kingdom and was reunited with Penelope.

See also **Odyssey; Ulysses.**

**Peneplain** is a once hilly or mountainous area that has been almost flattened by erosion. The prefix *pene* comes from a Latin word meaning *almost.*

Peneplains form in humid climates. They seem to develop when streams wear away rock and soil from the walls and floors of narrow, V-shaped valleys. This erosion process continues for millions of years until the streams have cut to the lowest level they can reach. All that remains is a gently rolling plain. In some cases, low, widely spaced peaks called *accordant summits* rise above this surface.

Movements in the earth's crust may raise the level of a peneplain, or fractures and folds in the land may occur. Erosion then starts again.

**Penfield, Wilder Graves** (1891-1976), was a Canadian neurologist who perfected a surgical cure for some forms of epilepsy. In these forms of the disease, epileptic seizures originate in small clusters of damaged brain cells. Penfield developed techniques for locating such cells and removing them surgically.

Penfield also mapped the areas of the brain that control various bodily activities. He showed that the brain's control of such activities as speech and memory is temporarily stopped when electric currents are applied to certain parts of the brain. In this way, Penfield located a speech area of the brain in the rear of the left half of the cerebrum. He also discovered that electric stimulation of the *temporal lobe,* a part of the cerebrum, activated memories of earlier experiences. He concluded that some memory is stored in the temporal lobe.

Penfield was born in Spokane, Washington, U.S.A. He graduated from Oxford University in 1916 and received his M.D. degree from Johns Hopkins University, Maryland, U.S.A., in 1918. Penfield became a Canadian citizen in 1934. That same year, he established the Montreal Neurological Institute, which he directed until his retirement in 1960.

**P'eng-hu.** See **Pescadores.**

**Penge.** See **Bromley.**

**Penguin** is an unusual bird that stands upright on very short legs and walks with an amusing, clumsy waddle. Penguins cannot fly but are excellent swimmers.

Penguins live in the southern half of the world. Several kinds, including the *Adélie* penguin and the *em-*

**Most species of penguins** build their nests and raise their young in huge colonies called *rookeries.* This picture shows part of an enormous rookery of king penguins on South Georgia, an island in the South Atlantic Ocean.

**Penguins are excellent swimmers.** Adélie penguins, *above,* swim rapidly in leaps and dives along the surface of the water.

**A pair of Adélie penguins** stand over the two eggs in their nest. A female penguin lays from one to three eggs, depending on the species, but most penguins lay two. The eggs hatch in one or two months.

**Adult penguins** provide food and warmth for their young. A small emperor penguin huddles under the warm body of an adult, *left.* An Adélie penguin feeds its young, *above,* by vomiting partially digested fish.

*peror* penguin, live on the ice of the Antarctic. Others are found farther north in areas touched by cold sea currents that originate in Antarctica. The *little* or *fairy penguin* lives off the coasts of southern Australia and New Zealand, *jackass penguin* lives off the coast of South Africa, and the *Galapagos penguin* lives only in the Galapagos Islands which lie almost on the equator. Penguins are not found in other areas of the world because they will not cross into warm ocean water from the cold Antarctic currents.

**Appearance.** All penguins have short, thick feathers on their stocky bodies. Their feathers are white on the belly and black or bluish black on the back. Some penguins have crests of long feathers on the sides of their heads and patches of brightly coloured feathers on their short, thick necks.

Penguins lost the ability to fly millions of years ago. Their wings developed into flippers, which serve as paddles in the water. These flippers, and the webbed feet, make penguins marvellous swimmers and divers. Their short, dense feathers form a waterproof coat. Thick layers of fat keep penguins warm in cold water.

The largest penguin, the emperor penguin, stands about 1.2 metres high and weighs about 45 kilograms. The 15 other *species* (kinds) differ in size. The smallest species, the little or fairy penguin, is only about 40 centimetres high.

**Habits.** Penguins eat fish. They spend much of their lives in water, but lay eggs and raise their young on land or on ice. While on land, they make their nests in enormous colonies called *rookeries.* A single rookery may contain as many as a million birds. Most species make their nests on bare ground or in grass. They lay their eggs in shallow hollows scraped in the earth or on low platforms of stones. A few species lay eggs in tunnels dug in the ground.

Emperor penguins have remarkable nesting habits. The female bird leaves the ocean at the start of the Antarctic autumn. She lays a single egg on bare ice, and immediately returns to the water. The male takes over the job of keeping the egg warm until it hatches. He rolls the egg onto his feet and covers it with the lower part of his belly, which has several rolls of fat.

Carrying the egg on his feet, the male penguin joins a large group of other males. The males huddle together to keep warm. For two months, the males keep the eggs warm. They do not eat during this period.

When the *chick* (young penguin) hatches, the male feeds it a milklike substance produced in his *crop* (throat). He feeds the chick through his mouth.

Soon after the chicks have hatched, the females return to the colony to care for them. The males then go to sea to get food for themselves and for the chicks. After three weeks, the males return with food. The chicks are herded into tight groups. The adults form a circle around them for warmth. In six months, the young penguins can take care of themselves.

**Scientific classification.** Penguins make up the penguin order, Sphenisciformes, and the family Spheniscidae. The Adélie penguin is *Pygoscelis adeliae,* the little or fairy penguin is *Eudyptula minor,* the jackass penguin is *Spheniscus demersus,* the Galapagos penguin is *S. mendiculus,* and the emperor penguin is *Aptenodytes forsteri.*

See also **Animal** (picture: Animals of the polar regions); **Antarctica** (Animal life).

**Penicillin** is a powerful drug used to treat infections caused by bacteria. It was the first *antibiotic* (drug produced by microbes) used successfully in the treatment of serious diseases in human beings. Sir Alexander Fleming, a British scientist, discovered penicillin in 1928. Various forms of the drug have become widely available for medical use since the mid-1940's. Penicillins have played a major role in treating pneumonia, rheumatic fever, scarlet fever, and many other diseases. The development of penicillins had a tremendous impact on medicine and encouraged research that led to the discovery of many other antibiotics.

**Forms of penicillin.** There are many kinds of penicillins. All of them are obtained from moulds of the genus *Penicillium.* Chemists isolate some penicillins naturally by processing *Penicillium* moulds in various ways. Other penicillins, called *semisynthetic penicillins,* are produced by chemically changing natural penicillin substances. *Penicillin G* is by far the most widely used natural penicillin. Commonly used semisynthetic penicillins include *ampicillin, amoxycillin,* and *penicillin V.*

**How penicillins work.** Penicillins kill bacteria by preventing the formation of the stiff cell walls bacteria need to survive. The body cells of human beings and animals do not form stiff cell walls and so are not damaged by penicillins.

Some penicillins are taken by mouth. But other penicillins are destroyed by stomach acids before they reach the bloodstream when given orally. Doctors usually give such penicillins by injection.

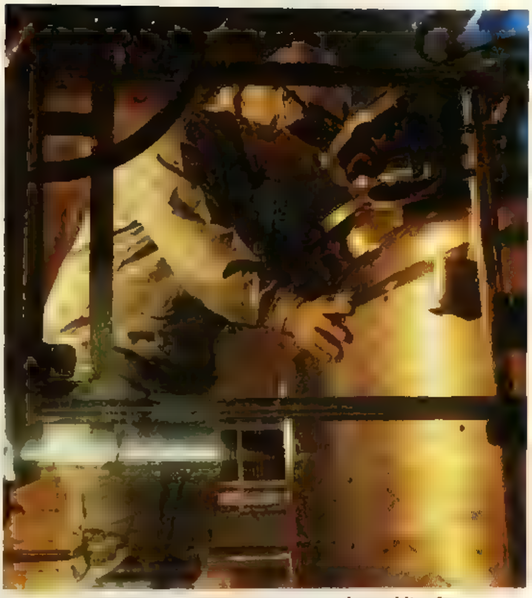
Most people who take penicillins experience no side-effects. However, some people suffer allergic reactions. Usually, these reactions involve only minor problems, such as fever or rashes. But life-threatening reactions involving shock and breathing difficulties occur in some patients. Patients allergic to one form of penicillin are allergic to all forms of the drug.

**History.** Fleming discovered penicillin in 1928 when he noticed mould growing in a laboratory dish that contained bacteria. Examining the dish, he saw that bacteria around the mould had been killed. He then grew the mould in a *broth* (liquid) and observed that the broth kept bacteria from growing in test tubes. However, Fleming had trouble extracting the bacteria-killing substance from the broth.

During the late 1930's, a group of British researchers led by Howard Florey and Ernst Chain developed a method of extracting and purifying small amounts of penicillin. Doctors first used penicillin to treat a human being in 1941, when the drug was given to a British policeman suffering from blood poisoning. However, the patient died because the supply of penicillin was inadequate to kill the infectious bacteria.

During the next several years, researchers found methods of producing large quantities of penicillin. They also discovered ways of obtaining several forms of the drug from broth. Of these forms, the type that was known as penicillin G proved the most effective in fighting bacteria. Doctors used penicillin G to cure people of many disorders, including pneumonia, rheumatic fever, syphilis, and strep throat.

However, doctors had difficulties in using penicillin G. For example, they found that it was not absorbed into the blood well when given orally. Also, penicillin G did not kill certain kinds of bacteria. Other bacteria—particularly *Staphylococcus aureus,* which causes blood poisoning, pneumonia, and many other disorders—became resistant to penicillin G after a few years.



**In a penicillin factory,** workers wear masks and lint-free clothes to keep the antibiotic free from impurities. A worker, *above,* observes liquids being mixed in a huge tank.

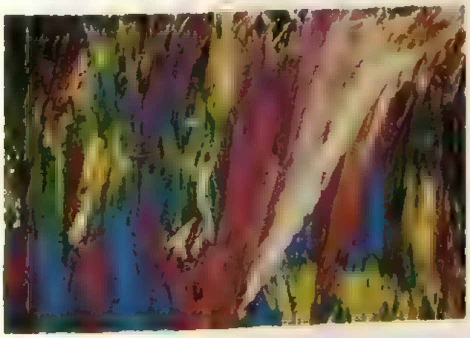
To overcome the problems with penicillin G, chemists began to make semisynthetic penicillins in the late 1950's. Today, many semisynthetic penicillins are available. Most of them have one or more properties that penicillin G lacks. For example, penicillin V kills the same bacteria as penicillin G but is absorbed into the blood better. Ampicillin and amoxycillin are effective against some kinds of bacteria resistant to penicillin G. These two penicillins are widely used in treating infections of the urinary tract and severe throat and ear infections in children.

**Related articles** in *World Book* include:

Antibiotic
Chain, Ernst B.
Fleming, Sir Alexander
Florey, Lord
Fungi (Importance)
Medicine (picture: Penicillium mould)
Tyndall, John

**Producing penicillin** Penicillin is one of the most widely used antibacterial drugs. It is produced by moulds of the genus *Penicillium, left.* Manufacturers grow the mould in huge tanks of broth. They extract the penicillin from the mould and broth, ending up with crystals of pure penicillin, *centre.* The crystals are then processed into tablets and solutions, *right.*

**A colony of *Penicillium***



**Magnified penicillin crystals**

**Tablets and solution**

**Peninsula** is an area of land that is nearly surrounded by water. Some peninsulas, such as India, are joined to the mainland by a broad base. Others are connected by a narrow strip of land, called an *isthmus* (see **Isthmus**). Arabia, the world's largest peninsula, covers about 2,600,000 square kilometres.

**A typical peninsula**

**Peninsular War.** See **Napoleon I** (The Peninsular War); **Spain** (French conquest).

**Penis** is an external male reproductive organ. In men and most other male mammals, both urine and a sperm-carrying fluid called *semen* leave the body through the penis. The penis is shaped somewhat like a finger. It hangs between the legs and is attached to the pelvic bones by connective tissues.

Thin, hairless skin covers the penis. Inside are three adjoining cylinders of spongy tissue that contains many blood vessels. These cylinders are bound together by a fibrous sheath. One of them encloses the *urethra,* a passageway for semen and urine. The urethra ends as an opening in the tip of the penis. The tip, called the *head* or *glans,* is slightly enlarged and has highly sensitive nerve endings. A fold of skin called the *foreskin* or *prepuce,* covers the glans. In many males, the foreskin has been removed by a surgical procedure called *circumcision* (see **Circumcision**).

The penis is usually soft and limp. Sexual excitement increases the flow of blood to the organ, filling its tissues and making it stiff and erect. The stiffened penis, called an *erection,* enables the male to have sexual intercourse. In a sexually mature male, stimulation of the erect penis leads to *ejaculation,* the discharge of semen that accompanies sexual climax. After ejaculation, the drainage of blood returns the penis to its resting state.

See also **Bladder; Prostate gland; Reproduction** (Human reproduction); **Sex.**

**Penitentiary.** See **Prison.**

**Penmanship.** See **Handwriting.**

**Penn, William** (1644-1718), was a famous English Quaker who founded the American state of Pennsylvania. The Quakers, or Friends, were often treated harshly in England. They wanted the right to follow their religious beliefs without scorn or fear of violence. Penn, one of their leaders, persuaded King Charles II to let them set up a colony in America. This colony became the state of Pennsylvania.

**Youthful rebel.** Penn was born on Oct. 14, 1644, in London, the son of a naval officer later knighted as Admiral Sir William Penn. The boy went to school in Essex. He entered Christ Church, Oxford University, in 1660. This was the year the Stuart family returned to the throne of England. Penn opposed the university rule that everyone must attend the Church of England. He believed in religious freedom and the right of individuals to worship as they pleased. Penn met with other rebellious students, outside the university, and was expelled from school. His father then sent Penn to France and Italy, hoping that the fashionable life there would make the boy forget his religious beliefs, or at least change them.


**William Penn,** an English Quaker, founded the colony of Pennsylvania in 1681. The above portrait of Penn was drawn in chalk about 1700 by Francis Place, an English artist.

Penn returned after two years of travel and study. The signs of his religious zeal were gone. His father, glad for this change, sent him to study law in London.

Penn went to Ireland in 1667 to manage his father's estates. There, he became acquainted with Thomas Loe, a Quaker preacher. Loe convinced him of the "truth" of the Quaker faith. Penn was then 22 years old. He had a brilliant future ahead of him, but he put it aside to become a Quaker at a time when Quakers were scorned, ridiculed, imprisoned, and sometimes banished. His father was heartbroken.

**Persecution.** Penn was imprisoned several times for writing and preaching about Quakerism. He was first imprisoned in the Tower of London. After eight months, his father managed to have him released. During this imprisonment, Penn wrote *No Cross, No Crown* (1668), a piece explaining Quaker beliefs and practices.

In 1670, he was arrested at a Quaker meeting and accused of planning with another Quaker to start a riot. A jury found Penn not guilty of any crime. But the judge threatened to fine or imprison the jurors unless they changed their verdict. When they refused to do so, the jurors were in fact imprisoned. But on appeal, England's highest judges prohibited the penalizing of jurors. This action helped establish the independence of juries in English law.

In 1677, Penn went to the Netherlands and Germany with George Fox and other Quaker leaders (see **Fox, George**). In these countries, Penn met other Quakers who were eager to settle in a free, new land. Some people in England also wanted to settle where they could worship in their own way without fear. Penn realized that the only hope for the Quakers was in America.

*Landing of William Penn* (about 1919), an oil painting on canvas by J. L. G. Ferris, Smithsonian Institution, Washington, D.C.

**Penn first saw Pennsylvania** when he arrived there from England in 1682. He had set up the colony to provide a place where Quakers and people of other faiths could have religious freedom.

**Founds Pennsylvania.** Charles II owed Penn's father many thousands of pounds. In 1680, Penn asked the king to repay the debt with wilderness land in America. On March 4, 1681, a charter was granted, giving Penn the territory west of the Delaware River between New York and Maryland. The charter also gave him almost unlimited ruling power over it. The king's council added *Penn* to the suggested name of *Sylvania,* making *Pennsylvania,* which means *Penn's Woods.* Penn drew settlers, including many Quakers, with promises of religious liberty and cheap land. Several thousand people travelled to Pennsylvania from England, Germany, the Netherlands, and Wales. Penn drew up a frame of government for his colony which greatly influenced later charters. It authorized an elected assembly and may even have influenced the Constitution of the United States.

In October 1682, Penn sailed up the Delaware River, and saw his colony for the first time. That same year, he made his first treaty with the Indians. His dealings with the Indians were so fair that they never attacked the colony. Penn returned to England in 1684 after the colony was well started.

**Arrested again.** In his drive for religious tolerance, Penn had become a close ally of King James II of England, a Roman Catholic. James granted pardons to Quakers and other religious prisoners. But the Glorious Revolution of 1688 brought William and Mary to the English throne, and James fled abroad. Penn was suspected of plotting the return of James, and was arrested several times. In 1692, his colony was placed under royal control. Penn wrote two of his greatest works in 1693. One was *An Essay Towards the Present and Future Peace of Europe,* a plan for a league of nations in Europe based on international justice. The other, *Some Fruits of Solitude,* was a short book that described general principles for proper living. In 1694, Penn's colony was restored to him. That same year, Penn's wife, Gulielma Maria Springett Penn, died. They had married in 1672 and had eight children. In 1696, Penn married Hannah Callowhill, who was to bear him seven more children.

Penn returned to Pennsylvania in 1699. Problems had arisen in the colony over government, piracy, and illegal trade. Penn had some success solving these issues. He granted a new constitution, the Charter of Privileges, in 1701. This document created a *unicameral* (one-house) elected assembly with greater power. The provincial council was reduced from a legislative body to a small group of advisers to the governor. Efforts by the English government to place all proprietary colonies under royal control caused Penn to return to England in 1701. He never saw America again.

The government attempt to gain control failed. But Penn was arranging to sell Pennsylvania to the English crown in 1712, when he suffered a stroke. The stroke impaired his mental ability and eventually paralysed him. From 1712 until his death, Penn's affairs in Pennsylvania were handled by his wife and by his colonial secretary, James Logan. Pennsylvania remained a proprietary colony in the Penn family until it gained statehood during the American Revolution (1775-1783).

See also **United States, History of the** (picture: Early colonists).

**Pennell, Joseph** (1857-1926), was an American printmaker. Pennell became best known for his lithographs and etchings, but he also created silk-screen prints, engravings called *mezzotints,* drawings, and watercolours. Pennell experimented with various inks and antique papers to produce unusual effects in some of his prints. His most famous works include lithographs of factories, New York City skyscrapers, and scenes of the construction of the Panama Canal.

Pennell was born in Philadelphia, where he studied drawing and etching. He moved to London in 1884. There he became a close friend of the American artist James A. M. Whistler, who strongly influenced his style. While in London, Pennell and his wife, Elizabeth Robins, wrote books on lithography and etching and a biography of Whistler. Pennell and his wife returned to the United States in 1917.

**Penney, Lord** (1909-1991), William George Penney, was responsible for designing and testing the first British atomic bomb. He was chairman of the United Kingdom Atomic Energy Authority from 1964 to 1967, when he became rector of Imperial College of Science and Technology, London University. Penney was born in Gibraltar and educated at Imperial College. His early research was on the application of quantum theory to chemistry. His book *Quantum Theory of Valency* (1935) describes the architecture of molecules and the energies needed to promote reactions.

**Lord Penney**

**Pennine Alps.** See Switzerland (The Swiss Alps).

**Pennine Hills** are a series of uplands in northern England. They run through the central part of the country, starting in Northumberland and Cumbria, and extending south to Derbyshire and Staffordshire. The highest point in the Pennines is Cross Fell, 893 metres above sea level. The Pennine Hills are rich in minerals, especially coal. A number of important rivers, including the Tyne and the Tees, rise in the Pennines.

**The Pennine Hills** run through the centre of northern England. Many walkers follow the Pennine Way, a footpath that stretches over the hills for about 400 kilometres.

The *Pennine Way* is a long-distance footpath which runs along the Pennine Hills. The way starts at Edale, near Chapel en le Frith in Derbyshire. It leads north for about 400 kilometres. The northern end is at the Scottish border near Kirk Yetholin in Borders Region. The Pennine Way was first suggested in 1935 by Tom Stephenson, a journalist and member of the Ramblers Association. Government approval was given for the idea in 1951, but it was not until 1965 that the footpath was officially opened. Since then, many walkers have been along the way, or parts of it. The Pennine Way has been featured in a number of television programmes and in travel books.

**Pennsylvania,** an eastern state of the United States, is a leading manufacturing and industrial centre. Pennsylvania is a historic state which was central to the American Revolution, leading to independence for the U.S.A. Harrisburg is the capital of Pennsylvania. Philadelphia is the largest city.

Philadelphia, in southeastern Pennsylvania, is the state's leading manufacturing city. It is one of the nation's great cultural, educational, financial, and historic centres and also a chief port. Pittsburgh, on the Ohio River in western Pennsylvania, is an important steel-producing city. The world's largest chocolate and confectionery factory is in Hershey.

Many tourists travel through the section of southeastern Pennsylvania in which the *Pennsylvania Dutch* people live. Most of the Pennsylvania Dutch people are descended from German immigrants. They were called *Dutch* because the word *Deutsch,* which means *German,* was misinterpreted. The Pennsylvania Dutch are known for fine cooking and for the colourful designs on many of their buildings and belongings. Some Pennsylvania Dutch groups, including the Amish and Mennonites, are called the *Plain People.* Many live and dress as their ancestors did and do not use electricity, cars, telephones, or modern machinery.

Pennsylvania played an important role in the earliest history of the United States. The Declaration of Independence and the United States Constitution were both

**Facts in brief**

**Population:** 11,924,710.
**Area:** 117,348 km².
**Climate:** *Average January temperature*— –3° C. *Average July temperature*—22° C.
**Elevation:** *Highest*—Mount Davis, 979 m. *Lowest*—sea level along the Delaware River.
**Largest cities:** Philadelphia (1,585,577), Pittsburgh (369,879), Erie (108,718), Allentown (105,090).
**Chief products:** *Agriculture*—milk, maize, hay, beef cattle, greenhouse and nursery products, eggs. *Manufacturing*—chemicals, food products, machinery, electrical equipment, primary metals, metal products, transportation equipment, printing. *Mining*—coal, natural gas, stone.
**Origin of name:** In honour of William Penn. The word *Pennsylvania* means *Penn's woods.*
**Nickname:** The Keystone State. (It was the centre, or keystone, of the "arch" formed by the original 13 states.)

**A scenic Lancaster County farm** lies amid the rolling plains of Pennsylvania's Piedmont region. This area in the southeastern part of the state has some of the United States' richest farmland.

adopted in Philadelphia. The historic Battle of Gettysburg was fought on Pennsylvania soil during the American Civil War (1861-1865).

**Land.** During the Ice Age, which ended about 10,000 years ago, glaciers spread into northern Pennsylvania. They formed some of the state's striking natural features. Forests cover about three-fifths of the state.

Pennsylvania has seven main land regions. *The Erie Lowland* covers parts of Pennsylvania and New York. It is a narrow strip in the northwestern corner of Pennsylvania, on Lake Erie's shores. Vegetables and fruit, especially grapes, thrive in its sandy soil.

*The Appalachian Plateau,* also called the *Allegheny Plateau,* extends from New York to Alabama. It covers most of the northern and western portions of Pennsylvania. The plateau consists of deep, narrow valleys and broad-topped *divides* (land ridges from which rivers flow in opposite directions). The Allegheny Mountains rise at the plateau's eastern edge. Southwestern Pennsylvania has high, rugged land. The western Appalachian Plateau has many coal, gas, and oil fields. The Pocono Mountains, a popular tourist area, are in the northeastern part of the plateau.

*The Appalachian Ridge and Valley Region* extends from New York to Alabama. In Pennsylvania, it forms a wide strip of land that curves south and east of the Appalachian Plateau. The area where the ridge and valley region and the plateau meet forms a large physical barrier. A fertile area called the Great Valley sweeps along the southern and eastern boundary of Pennsylvania's ridge and valley region. North and west of the Great Valley, the region consists of a series of long, parallel ridges and valleys that belong to the Appalachian Mountain system. Hard coal fields and slate formations are in the eastern part of the region.

*The Blue Ridge* stretches from southern Pennsylvania to Georgia. In Pennsylvania, it forms a narrow, finger-shaped region at the state's south-central border.

*The Piedmont* extends from New Jersey to Alabama. In Pennsylvania, it covers most of the southeastern part of the state. The region has rolling plains, and low hills with irregular ridges and fertile valleys.

*The New England Upland* extends from Pennsylvania to Maine. It forms a narrow rectangular ridge in the eastern section of Pennsylvania.

*The Atlantic Coastal Plain* stretches from New York to southern Florida. In Pennsylvania, it is a narrow strip of land that crosses the southeastern corner. The region is low, level, and fertile.

**Economy.** During the early 1900's, Pennsylvania became one of the world's leading centres of heavy industry. Large factories that produced steel and machinery were built in many areas of the state. During World War II (1939-1945), Pittsburgh's steel mills produced more steel than Germany and Japan together.

Heavy industry has declined in importance in Pennsylvania since about 1960. Today, the state's chief manufactured products are chemicals and processed foods. Large pharmaceutical companies operate in the Philadelphia and Pittsburgh areas. The Philadelphia area is Pennsylvania's chief production centre for processed foods and most other manufactured products. The state's other large manufacturing cities include Allentown, Bethlehem, Erie, Lancaster, Reading, Williamsport, and York.


**Pennsylvania** lies in the northeastern United States. The state is made up of hills, plateaus, ridges, and valleys.

Service industries employ about three-fourths of Pennsylvania's workers. Business services, finance, health care, and trade play major roles in the state's economy. Pittsburgh has the state's largest banking companies. Philadelphia has a stock exchange and several large holding companies. Both Philadelphia and Pittsburgh have famous medical centres. The Port of Philadelphia handles much foreign trade, especially imported petroleum.

Tourism in Pennsylvania thrives in Philadelphia, along Lake Erie, in the Pocono Mountains, and in the Pennsylvania Dutch area. Spending by tourists benefits hotels, and such retail trade businesses as restaurants and shops.

Eastern Pennsylvania supplies all the *anthracite* (hard coal) that is produced in the United States. Other parts of the state mine *bituminous* (soft) coal. Natural gas is the second most valuable mineral product, after coal. Most of the wells are in the west.

Farmland covers about a third of Pennsylvania. Pennsylvania is a leading state in the production of milk, the leading agricultural product. Maize and hay rank as the most valuable crops.

**History.** Indians probably lived in the Pennsylvania region hundreds or even thousands of years before white people arrived. Early white explorers found Algonquian and Iroquoian tribes there.

Swedes made the first permanent white settlements in the region. The Dutch captured the Swedish colony in 1655, and held it until 1664, when the English took control. In 1681, King Charles II of England granted the region to William Penn in payment of a debt to Penn's father. William Penn, a Quaker, wanted people of all faiths to have freedom of worship in Pennsylvania.

From the late 1600's to the middle 1700's, the English colonists fought several wars against the French colonists and France's Indian allies. In the French and Indian War, which began in western Pennsylvania in 1754, they fought for control of the Ohio River region and the interior of the continent. The war ended in 1763, with a British victory.

In the mid-1700's, Britain imposed new taxes and trade restrictions on its American colonies. Colonial leaders united to discuss how to resist these restrictions. The First Continental Congress met in Philadelphia on Sept. 5, 1774, and voted to stop all trade with Britain.

The American Revolution began in April 1775. That May, the Second Continental Congress met in Philadelphia and voted for independence from Britain. On July 4, 1776, Congress adopted the Declaration of Independence.

British troops captured Philadelphia in September 1777, and held the city until June 1778. The American general George Washington, and his troops spent the harsh winter and spring of 1777-1778 in Valley Forge. The Constitutional Convention met in Philadelphia in 1787. Pennsylvania became the second state to *ratify* (approve) the Constitution. Philadelphia served as the nation's capital from 1790 until 1800. After the American Revolution, Pennsylvania became a national centre of industrial growth.

Many Pennsylvanians were among the leaders of the U.S. *abolitionist* (antislavery) movement. During the American Civil War (1861-1865), Pennsylvania gave strong support to the anti-slavery Union side. On July 1, 1863, Union forces under General George C. Meade met General Robert E. Lee's Confederate troops at Gettysburg, in southern Pennsylvania. Lee retreated to Virginia following the three-day battle. Casualties were heavy on both sides. On Nov. 19, 1863, President Abraham Lincoln delivered his famous Gettysburg Address during ceremonies at the battlefield.

Pennsylvania prospered after the war. Existing industries expanded, and new industries developed. Thousands of immigrants moved to the state. But industrial growth also brought labour problems. Dissatisfied workers in many industries formed unions. Railway workers went on strike.

After the United States entered World War I in 1917, manufacturing and mining in Pennsylvania achieved even greater growth. During the Great Depression of the 1930's, hundreds of thousands of Pennsylvanians lost their jobs. The state and federal governments passed laws and set up programmes to ease the hardship.

Pennsylvania's economy recovered during World War II. The state produced huge quantities of goods for the armed services.

During the mid-1900's, Pennsylvania began to modernize in many fields, including transportation and urban development. Economic problems also developed during the 1950's. The state faced declines in the steel, coal mining, rail, and textile industries.

In 1979, an accident at the Three Mile Island nuclear power plant near Harrisburg threatened the release of deadly levels of radiation into the area. Scientists and technicians prevented a major disaster.

The steel industry declined in the late 1970's and early 1980's. As a result, many cities shifted to service industries and to industries that use new technology.

See also **Philadelphia; Pittsburgh; Penn, William.**

**Pennsylvania Dutch** refers to the people who came to the American colony of Pennsylvania in the 1600's and 1700's from the German Rhineland, and their descendants. Actually none of them came from the Netherlands. They were called *Dutch* because the word *Deutsch,* which means *German,* was misinterpreted. These settlers came to Pennsylvania mainly because of the promise of religious freedom there. They had suffered intolerance and persecution in Europe. By 1750, these settlers made up half the population of Pennsylvania.

See also **Amish; Mennonites; Moravian Church.**

**Pennsylvanian Period.** See Earth (table: Outline of the earth's history).

**Penny** is the name of various coins used in Great Britain, the United States, and other countries. The U.S.


**The British penny** honours Queen Elizabeth II on its front and has a royal crown and an iron gate with chains on the back.

penny is a cent. For many years, there were 240 British *pence* (pennies) in a pound. But in 1971, Great Britain switched to a decimal money system in which 100 *new pence* equal a pound. The penny was stamped with a cross until about 1500, during the reign of Henry VII. The coin could easily be broken into four equal parts and was used in halves as a *halfpenny* and in fourths as a *farthing.* The old penny was abbreviated *d*, but the new penny is abbreviated *p.* See also **Denarius.**

**Penny post.** See **Hill, Sir Rowland.**

**Pennyroyal** is the name of several herbs of the mint family. Pennyroyal leaves have a strongly pungent odour. The oil from various kinds of pennyroyal is used in medicine for its stimulating properties, in mosquito repellents, and in perfumes. European pennyroyal is a mint with prominent *whorls* (rings) of lilac flowers, and small drooping leaves.

**Scientific classification.** Pennyroyals belong to the mint family, Labiatae (Lamiaceae). The European pennyroyal is *Mentha pulegium.*

**Pennyweight** is a unit of measure in the troy system of weights. It is used to weigh gold, silver, platinum, coins, and most jewels. The pennyweight was once the weight of a silver penny. Today it is standardized as one twentieth of a troy ounce, or 24 grains (1.6 grams).

**Penology.** See **Criminology** (What criminologists study).

**Penrith** (pop. 149,682) is a city in New South Wales, Australia. It lies about 55 kilometres west of Sydney. The main western railway from Sydney passes through Penrith. The city's industries produce building materials, electrical equipment, industrial machinery, and clothing. Other industries include food processing and gravel extraction. Farming activities near Penrith include dairy farming, market gardening, fruit growing, and beef production. Governor Phillip originally named the Penrith settlement *Evan District,* after Evan Nepean, who was then undersecretary of state in the British Home Department. The name was changed to Penrith in 1818.

**Penrose, Jonathan** (1933- ), has been British Chess Champion in 10 different years. No one has ever won this title on as many occasions. Penrose represented Britain many times in international matches. In 1960, he beat the reigning world champion, Mikhail Tal, in Leipzig, Germany. The following year he received the title of International Chess Master from the International Chess Federation.

Penrose was born in Colchester, England, and educated at London University. In 1964, he became lecturer in psychology at Enfield College of Technology, London.

**Pension** is a regular payment made to a person when he or she reaches a certain age, or retires from work. A pension is intended to replace, or partly replace, the salary or other regular income previously received by a person. It is intended to provide financial security for individuals and their families. In the case of death of the recipient, the pension may be transferred to the recipient's husband or wife.

**State pensions.** In most industrial countries, pensions are provided by the state. Such pensions are usually a fixed, basic amount to which all people are entitled. The age at which such pensions may be claimed varies from about 55 years in some countries to 70 in others. Some countries have different qualifying ages for men and women. For example, in the United Kingdom, women receive a pension at age 60 and men at 65. But by the 1990's, most countries had abolished any difference in qualifying ages. State pensions are also known as *social security* and *old age pensions.*

Sometimes, a person may also receive a *supplementary pension.* The amount of this pension is linked to the level of wages or salaries received by the person during his or her working life. In particular cases, other pensions may be paid by the state for disablement, being widowed, or for injuries received during wartime.

In many developing countries, there is no welfare system to provide state pensions. Elderly people in such countries have to rely on their children or other relatives to house them and provide them with food, clothing, and other necessities.

**Occupational pensions** are pensions that are provided by employers for their employees. They are paid in addition to any state pension that might be available. In most countries, *civil servants* (employees of the government) are paid a regular pension when they retire. In the United Kingdom, the first pension scheme was designed in 1812, specifically for civil servants. People who work in the army, navy, or air force also receive pensions. Many members of the armed forces retire while they are still relatively young. They may take another job until normal retirement age, and receive their military pension in addition to earnings from the new job.

Many companies and other organizations have pension schemes. For self-employed people and those who do not receive a pension from their employer, there are *personal pension plans,* sometimes called *individual pension plans.* Conditions for these pensions are generally flexible, and contributions may be varied according to how much a person can afford to pay.

**Tax advantages** vary from country to country and according to the type of scheme. Contributions are generally paid by both the provider of the pension and by the employee or person who will receive the pension. The contributions are normally tax free and therefore cost less. This means that an employer is able to provide his employees with a valuable benefit at comparatively low cost. For the employee, it is an effective, low-cost method of saving for the future.

There are various types of pension schemes. These may be contributory or non-contributory. State schemes are contributory because they are partly paid for by the pension recipient through taxation or national insurance, which is deducted from salaries. In some occupational schemes, the employer meets the full costs of the benefits, and the employee makes no contribution.

**Final salary schemes** are so called because the amount of pension is guaranteed to be a certain proportion of the final salary. For example, an employee may be guaranteed a pension worth one-sixtieth of final salary for each year worked. After 30 years employment, that person would receive a pension worth 30-sixtieths, or half, of the final salary.

**Money purchase schemes** keep the contributions paid for, or by, an employee in a special fund. At retirement, the money is used to buy the pension.

**A lump sum of money** may be given as part of a pension at the time of retirement. This may be used according to the wishes of the recipient.

**Pension funds** are pools of money that pay for pensions and into which pension contributions are paid. The total value of some pension funds is enormous, and in many countries the economy depends on them for investment in housing, transportation, and manufacturing and other areas of wealth production. Generally, the use of pension funds is controlled by government legislation. Funds can be invested only in such a way that does not put them at great risk.

The amount of money needed to pay out pensions is carefully calculated. An *actuary* (statistician who specializes in measuring risk) is usually employed for this purpose. Actuaries work out how much money will be needed to pay pensions, based on the age and life expectancy of contributors and recipients. Pension fund managers may have to face the problem of fewer people joining a scheme than there are taking out pensions. They must carefully manage and invest the funds.

All over the world, the pensions business is increasing in size and importance. On average, people are living longer than in early periods of history. Increasingly, people plan ahead to have enough money to enjoy life when they retire. Expectations of retirement have been raised and people do not want their standard of living to go down when they grow old.

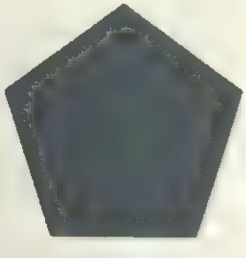
See also **Inflation; Profit sharing; Social security.**

**Penstemon** is the name of a large group of showy wild and garden flowers. Most penstemons are native to North America, especially the Western United States. The flowers are tube-shaped with the ends of the petals bent back. Each flower has five *stamens* (parts that contain pollen). However, the fifth stamen has no pollen and is often bearded with yellow hair. The colours of the flowers include blue, purple, rose, scarlet, and white.

Penstemons are grown from seeds, parts of roots, or cuttings. Penstemon plants grow best if they are exposed to full sunlight.

**Scientific classification.** Penstemons belong to the figwort family, Scrophulariaceae. They make up the genus *Pentstemon.*

**Pentagon** is a polygon having five sides. A pentagon is called *equilateral* if all its sides have the same length. It is called *equiangular* if all its angles are equal. Like all polygons, except a triangle, a pentagon may be equilateral without being equiangular. Or it may be equiangular without being equilateral. A pentagon is *regular* if all its sides are the same and its interior angles are equal. Each angle equals 108°, and may be inscribed inside a circle. A pentagon may be circumscribed around a circle by drawing tangents to the circle at the vertices of a regular inscribed pentagon. See also **Polygon.**



**An equilateral pentagon,** *above,* is a polygon that has five sides of the same length.

**Pentagon Building** is one of the largest office buildings in the world. It houses the headquarters of the Department of Defense of the United States government. The building lies on the west bank of the Potomac River in Arlington, Virgina, directly across from Washington, D.C.

Built in the form of a *pentagon,* or five-sided figure, the building's five concentric rings are connected by 10 spokelike corridors. It has five floors, a mezzanine, and a basement. The building covers 12 hectares and has about 344,200 square metres of office and other space. The outermost wall of the concrete structure is faced with Indiana limestone. It stretches about 1.6 kilometres around.

The building is surrounded by about 80 hectares of lawn and terraces. Parking areas adjacent to it cover 27 hectares, and can hold about 10,000 vehicles. The lagoon at the building's river entrance was formed by excavation and juncture with the river.

About 23,000 people work in the building. About half of them are civilians. Aside from the people who take care of the building, the officers, enlisted personnel, and civilians form parts of four groups. These groups are the Departments of the Army, Navy, and Air Force, and the Office of the Secretary of Defense.

The Pentagon Building has one of the world's largest private telephone systems, with about 160,000 kilometres of cable handling more than 200,000 calls a day. It also has the largest pneumatic tube system, comprising some 24 kilometres of tube. It also maintains what is probably the largest food service operation in the world. Restaurants and cafeterias there serve over 15,000 meals daily. The building also has a radio and television station, bank, dispensary, post office, and heliport.

Army engineers began building the Pentagon in September 1941, and completed it in 16 months, by January 1943. It was constructed originally to house the scattered offices of the War Department under one roof. The building cost 83,000,000 U.S. dollars.

**Pentameter.** See **Metre** (poetry).

**Pentas** is any one of a group of about 60 *species* (kinds) of plants in the madder family. Pentases grow in tropical parts of Africa, Madagascar, and Arabia. They are herbs or small shrubs and bear oval or spear-shaped leaves. Their trumpet-shaped flowers may be red, pink, purple, or white. People grow some kinds of pentases in gardens and greenhouses.

**Scientific classification.** Pentases belong to the madder family, Rubiaceae, genus *Pentas.*

See also **Madder.**

**Pentateuch** consists of the first five books of the Bible. They are, in order, the books of Genesis, Exodus, Leviticus, Numbers, and Deuteronomy. The term comes from two Greek words that mean *five books* or *five scrolls.* According to tradition, the books were written by the Israelite leader Moses based on revelations from God. The Pentateuch is often called the Five Books of Moses or the Torah (Law) of Moses.

The Pentateuch presents a continuous story from the Creation to the death of Moses and the preparation of the Israelites to enter Canaan. The story is told in three sections, sometimes called the *prehistory* or *primeval history,* the *protohistory,* and the *history.* The prehistory (Gen. 1-11) deals with the universal themes of the Creation and the beginning of human existence on earth. The protohistory (Gen. 12-50) presents the stories of several ancestors of the Israelites, notably Abraham, Isaac, Jacob, and Joseph. The historical portion, beginning with Exodus, describes the early history of Israel as a na-

**The Pentagon Building** is one of the largest office buildings in the world. The five-sided structure stands across the Potomac River from Washington, D.C.

tion. The conclusion in Deuteronomy is presented as Moses' final address to his people and a kind of historical summary of the Pentateuch.

The Pentateuch is the oldest part of the Bible, though scholars do not know the precise date of composition. The earliest materials may precede its final form by more than 1,000 years. Modern archaeological discoveries suggest that some of the oldest stories in Genesis may date back to the 2000's B.C.

See also **Bible** (The Old Testament); **Moses**; and the separate articles on each book mentioned.

**Pentathlon, Modern** is an athletic competition for men and women that tests skill in horse riding, fencing, swimming, pistol shooting, and running. Competitors participate in all five events, receiving a point score for each performance. The athlete with the highest point score wins. The modern pentathlon is held in both individual and team categories. It differs from the pentathlon, which consists of five track and field events.

The modern pentathlon is usually conducted over three or four days in the Summer Olympic Games and in world championships. First the competitors ride a horse over a 600-metre course with 15 obstacles. Fencing comes next. The third event is freestyle swimming, 300 metres for men and 200 metres for women. The final events are rapid-fire pistol shooting and a cross-country run of 4,000 metres for men and 2,000 metres for women.

See also **Olympic Games** (table: Modern pentathlon).

**Pentecost** is the feast that marks the end of the 50-day Christian observance of Easter. The term comes from the Greek word for "fiftieth." Pentecost originally celebrated both the Ascension of Jesus Christ and the descent of the Holy Spirit. In the 300's, the Ascension of Jesus came to be a separate observance (see **Ascension Day**). However, Pentecost remained a celebration of the gift of the Holy Spirit to the church, in fulfilment of Jesus' promise "And I will pray the Father, and he shall give you another comforter, that he may abide with you for ever" (John 14:16).

During early church history, the term *Pentecost* referred not only to the 50th day, but to the whole period of 50 days following Easter. This was the time of the celebration of the Resurrection of Jesus.

In the late 1900's, this emphasis is being recovered in a number of churches, including the Roman Catholic Church, the Eastern Orthodox Churches, most Lutheran churches, and the churches of the Anglican Communion. In these churches, the season of Easter is being observed throughout the seven weeks leading up to Pentecost.

In ancient Israel, Pentecost was the celebration of the wheat harvest held 50 days after the festival of Passover. Since Biblical times, the celebration also commemorates the day the Ten Commandments were revealed to Moses on Mount Sinai. In Judaism, this event is observed in the holiday of Shavuot, which falls in May or June.

See also **Easter; Shavuot; Trinity; Christianity** (The origin of Christianity).

**Pentecostal churches** are a group of Protestant churches that trace their origins to a religious revival that began in Topeka, Kansas, U.S.A., in 1901. The movement spread rapidly in the United States. Similar revivals took place in Europe, Asia, and Latin America. Today, some of the world's largest and fastest growing Protestant denominations are Pentecostal. It is estimated that there are about 100 million Pentecostals worldwide. The largest communities are in the U.S.A., Mexico, Brazil, Indonesia, Zaire, Nigeria, and South Africa.

**Beliefs and practices.** Pentecostals claim that all individual Christians should experience "baptism in the Holy Spirit." Proof of "Spirit baptism" generally comes when the person receives the gift of *speaking in tongues*—that is, speaking in an unknown language. Pentecostals take their name from the New Testament reference to the disciples speaking in tongues on the day of Pentecost (Acts 2). Pentecostals also believe that they can receive other gifts of the Holy Spirit. These gifts include the power of physical healing and the abilities

to prophesy and to interpret what is said when someone speaks in an unknown tongue. Such gifts are described in I Corinthians 12 and 14.

Pentecostals believe that history will end with the Second Coming of Jesus Christ. They believe their movement fulfils Biblical prophecies of a religious revival before the end of the world. They view *evangelism* (the spreading of their religious message) as a solemn obligation to prepare the world for Jesus' return.

Pentecostal worship services tend to be highly emotional and filled with a sense of the wonder and miracle of the Holy Spirit's presence. The celebration and use of spiritual gifts, as well as prayers for the healing of the sick, are typical practices in many congregations.

Apart from the shared beliefs described above, many Pentecostal churches differ greatly from one another. They differ in size as well as in their interpretations of faith and practice. For example, some Pentecostal denominations are controlled by the individual congregations. Others are led by bishops.

**Major Pentecostal churches.** In the United States alone, there are about 30 sizable Pentecostal denominations. Many other small, regional churches identify with the Pentecostal movement, though they do not call themselves Pentecostal churches. In addition, a related movement of *charismatic renewal* began during the 1960's. It involved many Protestants and Roman Catholics who claimed to have experienced Spirit baptism.

The earliest Pentecostal churches grew out of the *Holiness movement* of the late 1800's. Members of Holiness churches acknowledged two acts of grace: (1) conversion, or being "born again"; and (2) sanctification or a "second blessing," meaning a cleansing from sin.

Charles Fox Parham, an independent Holiness preacher, is believed to have originated the Pentecostal revival. In 1901, people began speaking in tongues at his Bethel Bible College in Topeka, Kansas. Parham claimed that such speech indicated "true baptism in the Spirit." He added Spirit baptism to the two acts of grace accepted by Holiness churches. William Joseph Seymour, a black Holiness preacher, brought the movement to the Azusa Street Apostolic Faith Mission in Los Angeles in 1906. Similar revivals also took place in many countries during the early 1900's. Since the 1950's, there has been a great expansion of Pentecostalism in Africa, Asia, and Latin America.

The first Pentecostal church was the Church of God (Cleveland, Tennessee, U.S.A.). This former Holiness church accepted Pentecostal teaching about Spirit baptism in 1907. Other Pentecostal churches with Holiness roots include the Church of God in Christ and the International Pentecostal Holiness Church.

Other Pentecostal churches reject the idea of a "second blessing." They teach only conversion and Spirit baptism. One such church, the Assemblies of God, is the largest Pentecostal church. See **Assemblies of God.**

A group of Pentecostal churches known as *Oneness churches* formed out of the Assemblies of God after 1916. These churches reject the traditional Trinity of the Father, the Son, and the Holy Spirit. Instead, they hold that the Bible calls for baptism only "in the name of Jesus." Such churches include the United Pentecostal Church International and the Pentecostal Assemblies of the World, Inc.

**Pentland Firth** is a narrow sea passage in northern Scotland. The firth separates the Orkney Islands from Highland Region on the Scottish mainland. At its narrowest point, between Duncansby Head and Brough Ness, the firth is only about 10 kilometres wide.

**Pentode.** See **Vacuum tube.**

**Pentolite.** See **Explosive** (High explosives).

**Pentothal.** See **Thiopental.**

**Penumbra** means *partial shadow.* Suppose an object such as the earth blocks the light given off by a larger source such as the sun. Behind the earth, there is a dark shadow where none of the sun's rays pass. Outside this dark region is another, less dark region, where some of the light passes. This partially dark region is called the *penumbra.* The inner dark region is called the *umbra.* The moon is almost totally dark when it passes through

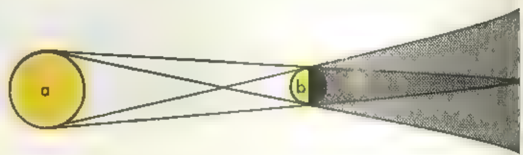



**Diagram of the penumbra.** The sun, the source of light, is labelled (a), while (b) is a sphere on which the light falls. The heavily shaded cone behind (b) shows the umbra, where there is almost total darkness. The lightly shaded area shows the penumbra, which is in partial shadow.

the umbra of the earth's shadow. This occurrence is called a *total eclipse* of the moon.

You can see an umbra and a penumbra in the shadow of your hand. Hold your hand at about 50 centimetres from a lamp in a room with no other light. Place a piece of white paper on the other side of your hand. Your hand casts a shadow on the paper. In the centre of the shadow of each finger is the dark umbra. Around each umbra is a brighter penumbra.

Astronomers also use the term *penumbra* to describe the outer region of a *sunspot* (a relatively dark area on the surface of the sun).

See also **Shadow; Sunspot.**

**Penwith** (pop. 59,400), in Cornwall, is England's most westerly local government district. Its extensive and attractive coastline includes such places as Land's End, St. Michael's Mount, and the tourist resorts of Penzance and St. Ives. Local people who fish for a living catch crabs and lobsters. Inland are areas of open moorland between sheltered valleys. Tourism, farming, and market gardening are the main industries. Engineering, mining, and quarrying are also important. See also **Cornwall.**

**Penzance** is a port and seaside resort in the far west of Cornwall, England, in Penwith local government district. It stands on the rocky coast of Mounts Bay. There are good beaches for bathing. Several Georgian and Regency houses line Chapel Street. Penzance is a terminal for marine and helicopter ferries to the Isles of Scilly.

**Peonage** is a system of forced labour in which the *peon* (labourer) is forced to work in payment of a debt. The word *peon* comes from the Spanish *peón,* meaning *day labourer.*

Peonage was common in most of the Spanish colonies of the Americas until the early 1900's, when nearly every civilized country of the world passed laws abolishing the practice. In Mexico, many Indians were forced to work out petty debts. The system was abolished in Mexico in 1917. But the term *peon* is still used to mean the impoverished Indian labourers of Latin America. These agricultural workers live on their employer's land and may receive a small payment for their work. The payment they receive is insufficient to pay off their debts, and they remain trapped in their poverty.

Peonage existed in the United States, particularly in the present states of New Mexico and Arizona, a short time after slavery was abolished. Blacks were arrested on false charges and fined. If they were not able to pay the fine, they were given to the highest bidder to work without wages for a period of time. At the end of this period, they could be arrested again and forced into service. In 1911, the U.S. Supreme Court declared all forms of peonage unconstitutional.

**Peony** is the common name of a group of over 30 species of plants with large, handsome flowers. In early spring, peonies have shrubby or herblike stems. The clusters of leafy shoots, red and shiny green in appearance, make a striking effect a few weeks before the flowers appear in late spring or early summer.

Many of the cultivated varieties of peonies are the offspring of two species, the *common peony* of southern Europe and the *Chinese peony*. The large flowers of the common peony are white, pink, red, or crimson and are lovely to look at, although they do not have much fragrance. Many of the Chinese peonies, a large group of hybrids, bear double, sweet-scented blossoms. The peonies with woody stems are called *tree* or *mountain peonies*. One species, native to western China, has showy flowers that blossom in white and rose-coloured hues and grow on a stalk from about 90 to 120 centimetres high. Tree peonies grow slowly. In regions of late spring frosts, the buds are often injured. Once established, they bloom season after season. Bush peonies are planted by dividing the shoots.

**Tree peonies** have large flowers that grow on tall stalks. This variety of the plant has white and rose-coloured blossoms.

**Scientific classification.** Peonies make up the peony family, Paeoniaceae. The common peony is *Paeonia officinalis;* the Chinese peony is *P. lactiflora.*

See also **Flower** (picture: Garden perennials).

**People.** See **Human being.**

**People's Temple.** See **Guyana** (History); **Cult.**

**Pepin the Short** (714?-768) became king of the Franks and founded the Carolingian dynasty. Like his father, grandfather, and great-great-grandfather, Pepin served as mayor of the palace in the Merovingian kingdom in France and Germany. In each case, the mayor was the power behind the throne. In 751, an assembly of the Franks deposed Childeric, the last of the weak Merovingian kings, and proclaimed Pepin king. Pope Stephen II gave his approval when he anointed Pepin and his sons in 754.

When Pope Stephen II, who ruled Rome, asked Pepin for help against the Lombard king, Pepin sent his army to save Rome. The Lombards had captured Ravenna, in northern Italy. Pepin recaptured the city and much of the nearby territory, and gave it all to the pope. The gift of the territory, known as "the Donation of Pepin," helped build the political power of the pope (see **Papal States**). Pepin added Aquitaine (now part of France) to his own kingdom, and began many important religious and educational reforms. After Pepin died, his son, Charlemagne, became king of the Franks and carried on these reforms (see **Charlemagne**).

**Pepper** is a spice. The familiar black pepper known in every household is the product of a trailing or climbing shrub grown in Indonesia and other countries with hot climates. The islands of Java and Sumatra are major producers of pepper.

The pepper plant bears a small green berry, which turns red as it ripens. The berries are gathered just

**The pepper plant** has large, shiny leaves and small green berries. The berries become red as they start to ripen, *above*. At this stage, the berries can be used to make black pepper. White pepper is obtained from fully ripened berries, *left*.

when they begin to change colour. They are cleaned, and then dried in the sun, or before a slow fire. In drying, the berries turn black. When the berries are ground and sifted, they form the black pepper that is known in households.

White pepper is made from the ripe berries of the same plant. These are bruised, and then washed until they are free from the pulpy matter and bits of stalk, and finally dried. White pepper has a finer flavour than black, but is not so strong. Red pepper is obtained from species of *Capsicum,* and Jamaica pepper, also known as *allspice,* is obtained from the pimento tree.

The sharp, biting taste of ordinary pepper is due chiefly to an acrid resin and oil it contains. Pepper also has medicinal value.

**Scientific classification.** The pepper makes up the pepper family, Piperaceae. Black and white pepper is *Piper nigrum.* Red pepper is a variety of *Capsicum annum.* Allspice is *Pimenta dioica.*

See also **Allspice; Capsicum** (with picture); **Cayenne pepper; Kava.**

**Pepper** is a shrubby perennial plant native to North and South America and grown primarily for its fruit. In areas where there is frost, peppers are grown as annuals. Botanists class the fruit of the garden pepper as a berry. Many seeds are contained within the fruit walls. The pungent flavour of some pepper varieties comes from *capsaicin,* a compound found in the walls of the fruit.

Farmers usually start the seeds in protected beds or flats in greenhouses or cold frames. Sometimes they soak the seeds in a nutrient solution before sowing. When the tiny plants are strong enough, the farmer transplants them to the fields, setting them about 60 centimetres apart, in rows about 90 to 120 centimetres apart. The plants grow from 90 to 120 centimetres high. The crop is grown like tomatoes, though the plants are not trained to stakes. The fruits are green when immature but turn red when ripe. The pepper plant is extremely sensitive to temperatures below 10° C and may be killed by even a slight frost.

**The green pepper** adds colour and flavour to food. Chilli peppers are more spicy than green peppers. They are ground and mixed with other spices for seasoning.

**Chilli peppers** are long, slender peppers that turn bright red when ripe. The spicy hot seeds and flesh of some types of chilli peppers are ground into *cayenne pepper,* a popular seasoning.

Although most varieties of peppers produce red fruits, there are some yellow-fruited varieties. There are also mild and pungent types. The large-fruited salad peppers and those grown and dried for paprika are mild (see **Paprika**). Pimento, a thick-walled mild red pepper, is often canned. Chilli peppers are very pungent.

Pepper plants are subject to a blight caused by bacteria, and also to a disease called *anthracnose.* Both of these conditions can be quite harmful to the plants. But they can be controlled with a combination of careful pesticide application and good cultivation practices.

**Scientific classification.** Peppers belong to the nightshade family, Solanaceae. The many different varieties belong to the species *Capisium frutescens.*

See also **Capsicum.**

**Pepper tree.** See **Peppertree.**

**Peppermint** is a perennial herb of the mint family. Farmers grow peppermint commercially for the fragrant oil produced in the leaves of the plant. Peppermint oil is one of the most popular flavourings for sweets, and it adds a pleasant taste to many medicines, mouthwashes, and toothpastes. Some medicines for toothaches and colic contain peppermint. Menthol, an ingredient of many medicines for colds and coughs, is made from peppermint oil. Menthol causes a sensation of coolness in the mouth. Dried peppermint is used to relieve *flatulence* (the build up of wind) and also as a stimulant.

The peppermint plant grows from about 30 to 90 centimetres high and bears smooth, sharply pointed, oval leaves and small, purplish flowers. The plant grows best in dark, rich, moist soil made up chiefly of decayed plant matter. Such soil occurs mainly in wetland areas that have been drained.

**Peppermint**

Peppermint is native to Europe and Asia and is widely grown mainly for its oil, which is used as a flavouring. The oil is extracted from the plant by steam distillation. The leaves of the peppermint plant are used to make tea.

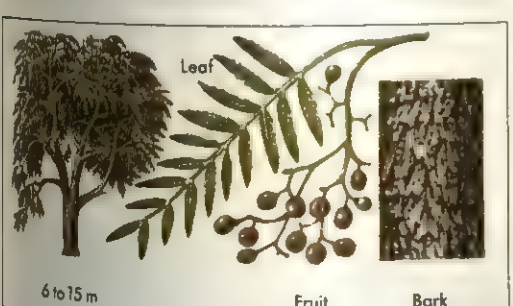
**Scientific classification.** Peppermint belongs to the mint family, Labiatae (Lamiaceae). It is *Mentha piperita*.

See also **Menthol; Mint.**

**Peppertree** gets its name from the strong-smelling berries that grow on it. It is not related to the familiar pepper plant. Pepper trees have drooping branches and bear yellowish-white flowers. The long leaves are filled with an oil that evaporates quickly. When the leaves are thrown into water, the oil escapes in jets with such force that the leaves jump as if alive.

Pepper trees are native to South America, but they are now also grown in the southwestern United States. They reach a height of about 15 metres.

**Scientific classification.** Pepper trees belong to the cashew family, Anacardiaceae, genus *Schinus*.




**The peppertree** gets its name from its strong-smelling red berries. The tree has drooping branches and long, thin leaves. It grows in warm parts of North and South America.

**Pepsin** is a digestive enzyme found in the gastric juice of the stomach. It changes proteins in food into substances called *peptides*. In chemical composition, pepsin is like other enzymes, but its effects are entirely different. Its activity is strongest in an acidic environment, such as that found in the stomach. Pepsin has no effect on fats or carbohydrates. It is produced commercially by drying the mucous lining of the stomachs of pigs and calves. There are several commercial preparations of pepsin. They can be given as an aid to digestion.

See also **Digestive system; Enzyme.**

**Peptide.** See **Protein** (The structure of proteins).

**Pepys, Samuel** (1633-1703), was an English writer and government official. His famous *Diary* provides an intimate self-portrait and a vivid picture of an exciting period in English history. Pepys also became known for his role in the development of the British Navy.

*Portrait of Samuel Pepys* (1666), an oil painting on canvas by John Hayls, National Portrait Gallery, London

**Samuel Pepys**

**His diary** covers the period from 1660 to 1669. It deals with an early part of Pepys's life, when he was clerk of the navy. He wrote the *Diary* in a code combination of shorthand, foreign words and phrases, and contractions of his own invention.

Pepys meticulously recorded events of his daily life. He wrote frankly about his affairs with women and his desire to become wealthy. He described his enthusiasm for music and the theatre, and his interest in collecting books and paintings. Pepys told of his public career and his pride in his success. The *Diary* documents his curiosity about everything from science to the gossip at the court of King Charles II. Pepys did not intend to have the *Diary* read by the public, and he wrote about himself with unusual honesty.

Pepys recorded many of the important events of the 1660's as a witness and participant. The *Diary* colourfully describes the restoration of the king as ruler of England. The work also contains thrilling accounts of the Great Plague, the Great Fire of London, and England's naval war with the Netherlands. In an especially memorable entry, Pepys related his court defence of the navy board after the board came under attack by a parliamentary committee.

Pepys stopped writing the *Diary* because his vision deteriorated. The work was first translated from 1819 to 1822 and was published in an abridged edition. The unabridged *Diary* was published in nine volumes from 1970 to 1976.

**His life.** Pepys was born in London and attended Cambridge University. Through the influence of a powerful relative, Sir Edward Montagu, he was appointed Clerk of the Acts of the Navy in 1660. This post gave Pepys a position on the navy board. His ability, dedication, and industriousness soon made him the most efficient administrator in the navy office.

In 1673, Pepys became Secretary of the Admiralty and thus, in effect, head of the navy. Under Pepys, the navy administration developed into an efficient, professional organization. Pepys introduced numerous changes that reflected a great capacity for detail. His reforms affected functions ranging from the appointment of naval officers to the maintenance of dockyards.

Pepys served in Parliament several times, and he was president of the Royal Society in 1684 and 1685 (see **Royal Society**). He lost his post in the admiralty after the fall of King James II in 1688. Pepys then wrote *Mémoires of the Royal Navy, 1679-1688,* which was published in 1690.

**Pequod.** See **Melville, Herman.**

**Perak** is a state in Peninsular Malaysia. Thailand forms the boundary to the north, Kelantan and Pahang to the east, Selangor to the south, and Kedah and the Strait of Malacca to the west.

### People and government.

Nearly 45 per cent of the population are Malay. About 41 per cent are Chinese and 14 per cent are Indian. Most of the Chinese live in the large towns, and the Malays live in the agricultural areas. The head of state of Perak is a *sultan* (ruler). The state legislative assembly has 46 seats. See **Malaysia, Government of.**

### Economy

The tin industry was the basis of the state's modern economy. The richest deposits were in the Kinta Valley. But since the 1980's, the tin industry has become less important. As deposits have become exhausted, marginal mines have closed, and controls have been placed on tin exports.

To counteract this decline, the state embarked on a programme to introduce new industries. It placed particular emphasis on the development of tourism. It also encouraged manufacturing, especially the processing of foodstuffs and wood, and high technology industries.

Agriculture is the most important economic activity in the state. The most important crops are coconuts, palm oil, rice, and rubber. The Krian district, with its substantial irrigation facilities, has long been one of the major rice-producing districts in the peninsula.

Forestry is also important in the economy of Perak. Timber is extracted from the mangrove forests, the lowland rainforests, and the mountain forests. Many people also work in commercial fishing from the small ports along Perak's coast.

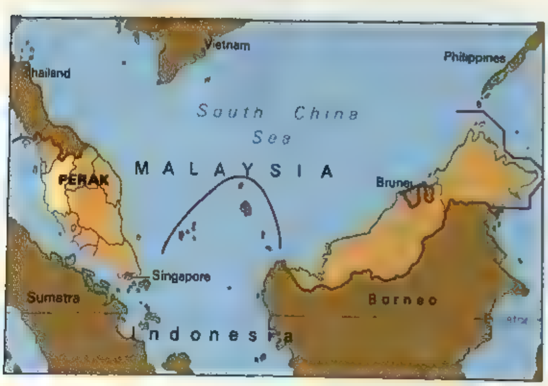
### Land

Perak's eastern border with Kelantan and Pahang lies along the crest of the Main Range, among whose peaks are Gunung Korbu and Gunung Batu Putih. This mountainous region is heavily forested. From the northern part of the Main Range, a short spur, the Kledang Range, extends southward into the state. Between the Kledang and the Main Range lies the Kinta Valley, one of the world's richest tin-mining districts. Ipoh, the state capital, lies in the Kinta Valley. To the west of the Kledang Range is the more substantial Bintang Range, whose major peaks include Gunung Bubu and Gunung Inas. The Perak River flows north to south between the Bintang and Kledang ranges. It rises in the mountainous north of the state, near the borders with Thailand and Kelantan, and discharges into the Strait of Malacca. The rest of Perak extends over the western coastal plain, and is mostly flat and poorly drained. There are extensive expanses of mangrove forest. The main west coast railway passes through Ipoh, Kuala Kangsar, and Taiping. Major highways pass from north to south and link the state with Kelantan, to the east. The most important ports are in Telok Anson (Telok Intan) and Lumut (Port Weld).


**The flag of Perak** has three colours representing the three branches of the ruling family. The emblem of Perak, *right,* features the crescent of Islam with a stylized rice flower as a crest.

#### Facts in brief about Perak

**Population:** *1991 census*—1,880,016.
**Area:** 21,005 km².
**State capital:** Ipoh.
**Largest towns:** Ipoh, Kuala Kangsar, Taiping, Telok Anson (Telok Intan).
**Chief products:** *Agriculture*—coconuts, palm oil, rice, rubber, timber, tobacco. *Manufacturing*—beverages, food, textiles. *Mining*—tin.




**Perak** is a state in Malaysia which forms a part of Malaysia's border with Thailand.

### History

There has been human settlement in Perak since prehistoric times. The state's most important archaeological site is near Lenggong in Upper Perak. There were probably Indian trading settlements on the coast before 1100, and permanent Malay settlements from the 1300's. In the early 1500's, Bruas, southwest of present day Ipoh, was a busy port and the main settlement in Perak.

Sultan Muzaffar, the eldest son of the last sultan of Melaka, established the present Perak sultanate in about

#### Places to visit

Following are brief descriptions of interesting places to visit in Perak:

**Ipoh** is the main town in the state. It has broad streets and a number of fine neoclassical colonial buildings, including the railway station. Ipoh also has a magnificent new state mosque. Towering hills, honeycombed with caves, rise around the town.

**Kuala Kangsar** is the royal capital of Perak. It contains the sultan's palace, the royal mosque, and the royal burial ground. Other buildings of interest are the Ubudiah Mosque, with its golden dome, and the royal residence, Istana Iskandariah.

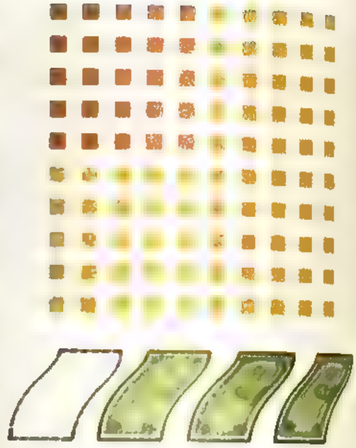
**Pangkor Island,** lying off the Perak coast, has the best beaches in the state.

**The Ubudiah Mosque** stands outside the royal town of Kuala Kangsar, in Perak. It is famous for its golden, onion-shaped central dome. Many people consider it the finest mosque in Malaysia.

1528. The state, even then, was famous for its mineral wealth (*Perak* means "silver" in Malay). As a result, foreign powers threatened the state almost constantly. During the 1500's, the Acehnese from the northern tip of Sumatra were the most serious threat. In 1641, the Dutch acquired Melaka, and began to seek control of Perak and its wealth. In an attempt to establish a monopoly over the state's trade, the Dutch constructed forts on Pangkor Island and at the mouth of the Perak River. In the 1700's, the threat to Perak came principally from the Bugis in Selangor to the south and from the Thais who dominated Kedah to the north. The rapidly growing international demand for tin from the mid-1800's brought major changes to Perak. From the 1840's, many Chinese miners came to the principal tin fields. The rapid expansion of tin production led to severe lawlessness. Chinese miners split into rival factions and fought for control of the richest tin-bearing land. By the late 1860's, a fierce succession dispute among the Malay rulers and conflict between Chinese gangs in Larut threatened to destroy the state. The supply of tin decreased sharply during this period.

The threat of anarchy prompted British intervention. Under the terms of the Pangkor Treaty of Jan. 20, 1874, the British settled the succession dispute and the new sultan accepted the appointment of a British *resident* (government representative). Many of the Malay rulers strongly opposed this settlement. In November 1875, Malay chiefs assassinated J. W. W. Birch, the first British resident. The British pursued the Malays who killed Birch and crushed possible resistance. In 1896, the British brought Perak, with Selangor, Negeri Sembilan, and

**Perak Royal Museum,** in Kuala Kangsar, is built in a unique and fascinating combination of architectural and decorative styles. It is one of the oldest museums in Malaysia and its collection includes artefacts made by the aboriginal people of the region.

**Percentage attracts shoppers** because it shows how much a buyer can save on a shop's regular prices. A sale at "25% off" means that regular prices have been reduced by $\frac{25}{100}$ or 0.25 or $\frac{1}{4}$ for a limited time.

Pahang into a Federation of Malay States (FMS), with the federal capital in Kuala Lumpur.

Under British administration, the economy of Perak grew rapidly. In the early 1900's, rubber challenged tin as the major export commodity. Both those commodities depended on Chinese and Indian labour and Asian immigrants arrived in huge numbers. Many of them settled permanently in the state.

During World War II (1939-1945), British rule in Perak collapsed from late 1941 as the Japanese advanced across the peninsula. With Japan's surrender in August 1945, the state once again came under British rule. In 1948, Perak became part of the Federation of Malaya. During the emergency of the late 1940's and early 1950's, there was a high level of Communist terrorist activity. The government took strong measures against the Communists. The Federation of Malaya became independent from British rule on Aug. 31, 1957.

See also **Malaysia**.

**Perak, Tun** ( ? -1498?), was *bendahara* (principal official) of the powerful Malay state of Melaka from about 1456 until his death. His father, Sriwa Raja, had been a Melaka bendahara before him. Sriwa Raja committed suicide after being disgraced. Tun Perak became headman of a small community at Kelang. In 1445, he led forces from Kelang to defend Melaka against the *Siamese* (Thais). This action reestablished his repututation in Melaka. During his years as bendahara, he served four Melaka sultans, to each of whom he was related.

Tun Perak played a part in Melaka's expansion over much of the Malay Peninsula and archipelago. Melaka became an important trading empire.

**Percale** is a closely woven cloth made from combed cotton yarn. It is used in making dresses, pyjamas, shirts, and other clothes.

Percale usually has a coloured *print* (design). It has a plain weave and a dull, smooth finish. Fine quality sheets are often called percale. Printed percale is often called *print*.

**Percentage** refers to computing by hundredths. You often see numbers such as 2%, 30%, and 75%. The % symbol means *per cent*. You read the numbers "2 per cent," "30 per cent," and "75 per cent." *Per cent* means *hundredths:* 2% means 2 hundredths, 30% means 30 hundredths, and 75% means 75 hundredths. *Per cents* are really *common fractions:* 2% is $\frac{2}{100}$, 30% is $\frac{30}{100}$, and 75% is $\frac{75}{100}$. *Per cents* are also *decimal fractions:* 2% is 0.02, 30% is 0.30, and, 75% is 0.75. Suppose you want to find 25% of 60. You must find $\frac{25}{100}$, or 0.25, of 60. The term *per cent* is from the Latin words *per centum,* which mean *by the hundreds.*

We use percentage frequently in everyday life. Bankers use percentage to compute interest on savings and loans. Our taxes are percentages of income, prices, and other amounts. Scientists often show the results of their observations and experiments with percentages. In baseball, team standings and batting averages are based on percentages. On clothing labels, percentages often represent the amounts of different fibres in the fabrics.

For hundreds of years, the business world has used the term *per cent,* and this custom has persisted to the present time. The custom may come from Roman taxes, which were often stated as $\frac{1}{20}$, $\frac{1}{25}$, $\frac{1}{100}$, and so on. In the Middle Ages, merchants commonly used hundredths and per cent even before the appearance of the decimal number system (see **Decimal system**).

After the introduction of the decimal system, people no longer needed to use the term *per cent.* It is just as easy to work with 0.25 as it is to work with 25%. However, percentage had become so deeply woven into business, professional, and everyday life that use of the term continued.

### How to change percentages to fractions

Per cent, in English, means *hundredths.* To change a *percentage* (the number of per cent) to a common or decimal fraction, you need only write the per cent as hundredths.

**Changing percentages to common fractions.** To change a percentage to a common fraction, drop the % symbol and write in a denominator of 100. For example:

$25\%=\frac{25}{100}=\frac{1}{4}$ $37.5\%=\frac{37.5}{100}=\frac{3}{8}$

$125\%=\frac{125}{100}=1\frac{1}{4}$ $265\%=\frac{265}{100}=2\frac{13}{20}$

**Changing percentages to decimal fractions.** To change a percentage to a decimal fraction, drop the % symbol and write in a decimal point two places to the left. Here are four examples:

$25\%=0.25$ $37.5\%=0.375$

$125\%=1.25$ $265\%=2.65$

### How to change fractions to per cents

**Changing common fractions to percentages.** To change a common fraction to a percentage, divide the numerator by the denominator to get a decimal fraction. Then move the decimal point two places to the right and attach the % symbol. Here are four examples:

$\frac{3}{5}=3\div5=0.60$ (60 hundredths)$=60\%$

$\frac{5}{8}=5\div8=0.625$ (62.5 hundredths)$=62.5\%$

$\frac{2}{3}=2\div3=0.66\frac{2}{3}$ ($66\frac{2}{3}$ hundredths)$=66\frac{2}{3}\%$

$\frac{7}{4}=7\div4=1.75$ (175 hundredths)$=175\%$

**Changing decimal fractions to percentages.** To change a decimal fraction to a percentage, move the decimal point two places to the right and attach the % symbol. Here are four examples:

0.07 (7 hundredths)$=7\%$

0.63 (63 hundredths)$=63\%$

0.625 (62.5 hundredths)$=62.5\%$

1.52 (152 hundredths)$=152\%$

### Solving percentage problems

Because percentage means hundredths, you should restate any percentage problem in terms of decimal or common fractions. Then you can solve it fairly easily as a fraction problem.

**How to find a percentage of a number.** Suppose you want to find 4% of 50. This means you want to find 4 hundredths of 50. First, change 4% to a common or decimal fraction.

$4\%=\frac{4}{100}$ $4\%=0.04$

In order to find 4% of 50, you must multiply 50 by the fraction that 4% represents:

$\frac{4}{100}\times50=\frac{200}{100}=2$ $0.04\times50=2$

So 4% of 50 is 2.

Here are some more examples:

*Find 30% of 72.*

$30\%=\frac{30}{100}$ $30\%=0.30$

$\frac{30}{100}\times72=\frac{2160}{100}=21.6$ $0.30\times72=21.6$

30% of 72 is 21.6

*Find $66\frac{2}{3}$% of 915.*

$66\frac{2}{3}\%=\frac{66\frac{2}{3}}{100}=\frac{200}{300}=\frac{2}{3}$ $66\frac{2}{3}\%=0.66\frac{2}{3}$

$\frac{2}{3}\times915=\frac{1830}{3}=610$ $0.66\frac{2}{3}\times915=610$

$66\frac{2}{3}$% of 915 is 610

*Find 250% of 32.*

$250\%=\frac{250}{100}=\frac{5}{2}$ $250\%=2.5$

$\frac{5}{2}\times32=80$ $2.5\times32=80$

250% of 32 is 80

**What percentage is one number of another?** Look at the statement $20 = 4 \times 5$. The numbers 4 and 5 are *factors* of 20. Suppose the factor 5 is missing: $20 = 4 \times ?$. You can find the missing factor by dividing 20 by 4: $20 \div 4 = 5$. Suppose the factor 4 is missing from the statement: $20 = ? \times 5$. You can find it the same way: $20 \div 5 = 4$.

Now suppose one of the factors is a fraction. Look carefully at the problem $30 = ? \times \frac{1}{4}$. You can find the missing factor by dividing 30 by $\frac{1}{4}$:

$$30\div\frac{1}{4}=30\times\frac{4}{1}=120$$

So $30 = 120 \times \frac{1}{4}$. Per cents are hundredths, so you can use this process to find what percentage one number is of another.

Suppose you want to find what percentage of 30 the number 15 is. First, write the problem in the form $15 = ? \times 30$. You can find the missing factor by dividing 15 by 30:

$15\div30=0.5$ $0.5=50\%$

So 15 is 50% of 30.

Here are two more examples:

*17 is what percentage of 340?*

$17=?\times340$

$17\div340=0.05$ $0.05=5\%$

17 is 5% of 340

*420 is what percentage of 70?*

$420=?\times70$

$420\div70=6$ $6=600\%$

420 is 600% of 70

These problems can also be solved by comparing ratios. For example, in determining what percentage of 30 the number 15 is, you are attempting to find a number that compares to 100 in the same way that 15 compares to 30. That is, you are looking for the number that, with 100, expresses the same ratio as the ratio of 15 to 30:

$\frac{15}{30}=\frac{?}{100}$ $15\times100=30\times?$ $\frac{1500}{30}=50$

So 15 is 50% of 30.

**Finding a number when a percentage is known.** Suppose you know that 6 is 25% of some number. What is the number? You can use the process of finding a missing factor to solve this problem. First, write the problem in the form $6 = 25\% \times ?$. Now 25% is 0.25, so the problem becomes $6 = 0.25 \times ?$. You can find the missing factor by dividing 6 by 0.25:

$$6\div0.25=24$$

So 6 is 25% of 24.

Here are some more examples:
*17 is 40% of what number?*

$$17 = 0.40 \times ? \qquad 17 \div 0.40 = 42.5$$

17 is 40% of 42.5

*46 is 115% of what number?*

$$46 = 1.15 \times ? \qquad 46 \div 1.15 = 40$$

46 is 115% of 40

## Applications of percentage

**Commissions.** Many companies pay their salespeople by giving them a *commission* (a certain amount of money for each article they sell). The commission is usually a certain per cent of the price of the article that is sold.

Suppose a salesman receives a 15 per cent commission on everything he sells. How much money does the salesman earn if he sells a refrigerator for 436 dollars ($436)? That is, what is 15 per cent of $436? First, remember that 15 per cent means 15 hundredths. You must find 0.15, or $\frac{15}{100}$, of 436.

$$15\% = \tfrac{15}{100} \qquad 15\% = 0.15$$

$$\tfrac{15}{100} \times \$436 = \$65.40 \qquad 0.15 \times \$436 = \$65.40$$

So the salesman earns $65.40 on the sale.

**Comparisons.** Percentage gives us a method of comparing quantities. It helps to make a comparison where the relationship is not easy to see at once. For example, percentage helps people to compare volumes of sales on the stock market. Companies often use percentage to compare their business gains and losses. Engineers use percentage to compare production rates with their goals. Here is an example concerning three football teams:

England won 12 games and lost 8 games.
Cameroon won 14 games and lost 11 games.
Argentina won 11 games and lost 6 games.

What is the relative standing of the teams?

To determine standing, you can compare the number of games won by each team to the number of games that team has played. First, you can see that England played 20 games and won 12 of them. What percentage of 20 is 12? Remember the process of finding a missing factor.

$$12 = ? \times 20$$
$$12 \div 20 = 0.60 \qquad 0.60 = 60\%$$

So the English team won 60 per cent of its games.

Cameroon played 25 games and won 14 of them. What percentage of 25 is 14?

$$14 = ? \times 25$$
$$14 \div 25 = 0.56 \qquad 0.56 = 56\%$$

The Cameroon team won 56 per cent of its games.

Argentina played 17 games and won 11 of them. What percentage of 17 is 11?

$$11 = ? \times 17$$
$$11 \div 17 = 0.647 \qquad 0.647 = 64.7\%$$

The Argentine team won 64.7% of its games.

Now you can arrange the teams on the basis of the percentage of games won:

| | |
|---|---|
| Argentina | 64.7 |
| England | 60 |
| Cameroon | 56 |

You can use percentage to compare other quantities.

**Interest.** When people borrow money from a bank, the bank charges them *interest* on the loan. Paying interest is like paying rent for the use of the money. Bankers usually compute interest by percentage.

Suppose a businesswoman borrows $6,000 from the bank. The bank charges her 6 per cent interest a year. How much interest does she have to pay every month? First, what is 6 per cent of $6,000?

$$6\% = 0.06$$
$$0.06 \times \$6{,}000 = \$360 \qquad 6\% \text{ of } \$6{,}000 = \$360$$

So the businesswoman must pay the bank $360 on her loan for one year. To find how much she must pay for one month, divide $360 by 12:

$$\$360 \div 12 = \$30$$

So the businesswoman must pay the bank $30 every month as interest on her loan. See **Interest.**

**Profits.** Businesses usually charge a price for an article that includes the article's cost and the company's own profit. This price is the *selling price.* Businesses usually compute their profits as percentages.

Suppose a dealer bought a bicycle from a manufacturer for $36. The dealer wants to make a profit of 25 per cent of the price for which the bicycle is sold. How much must the dealer charge for the bicycle and what will the profit be? To make a profit of 25 per cent, the cost of the bicycle from the manufacturer must be 75 per cent of the price the dealer charges. So the problem is to find the number of which $36 is 75 per cent. Remember the process of finding a missing factor.

$$75\% = 0.75$$
$$\$36 = ? \times 0.75$$
$$\$36 \div 0.75 = \$48 \qquad \$48 - \$36 = 12$$

So the dealer must charge $48 for the bicycle. The profit will be $12. As a check, you can see that the profit, $12, is 25 per cent (or one fourth) of the selling price of $48.

**Taxes.** Many prices include taxes. For example, the price of a bracelet usually includes a sales tax. This tax is usually computed as a percentage of an article's price before the tax is added.

Suppose a college sells tickets for a football game. Each ticket costs $1.50. The $1.50 price includes a 10 per cent sales tax on the college's income from the ticket. What is the income from each ticket? The price includes both income and the 10 per cent tax, so $1.50 must represent 110 per cent of the income. So the problem is to find the number of which $1.50 is 110 per cent.

$$110\% = 1.10$$
$$\$1.50 = ? \times 1.10$$
$$\$1.50 \div 1.10 = \$1.36 \textit{ (to the nearest cent)}$$

So the income that the college earns from each ticket sold is $1.36.

See also **Decimal system; Fraction; Graph; Statistics.**

**Perception** is the process by which we receive and interpret information from the world around us. The world around us consists of various kinds and levels of physical energy. Our knowledge of the world comes through our sense organs, which react to these energies. Certain wavelengths of electromagnetic radiation stimulate our eyes. Our ears sense certain kinds of mechanical vibrations in the air. Our noses and tongues are sensitive to certain chemical stimuli. Sense organs in our skin respond to pressure, temperature changes, and various stimuli related to pain. Sense organs in our joints, tendons, and muscles are sensitive to body movement and position.

The sense organs change the various environmental energies into nervous impulses, which go to the brain. Through the psychological process of perception, the patterns of energies become known as objects, events, people, and other aspects of the world.

The process of perception does not reveal objects and events of the world. We see light and colour, but there is no light or colour in the electromagnetic waves that stimulate the eyes. In the same way, there is no music or noise in the vibrations that stimulate the ear. The brain organizes and interprets nervous impulses from the eyes as light and colour, and impulses from the ears as sound. Together, the sense organs and the brain transform physical energy from environmental stimuli into information about the events around us.

When looking at the illustration on this page, you may first see only a complicated pattern of dark and light areas. As you study the pattern, your first perception may change, particularly if you are told that a bearded man is in the picture. After you have seen the man, it will be almost impossible not to see him when you look at the picture again.

This picture emphasizes two important points about perception. First, stimulation of the sense organs alone does not determine the nature of what is perceived. Second, perception is a dynamic process of "working on" sensory data to produce perceptual objects and events. The "work" involves many physical, physiological, and psychological factors.

**Hidden figure designs** show how we must "work on" sensory stimulation to perceive something recognizable. The face of a man with a beard and long hair appears in the top half of this design, in the centre. It is a front view, cut off above the eyes. Do not look for such details as the eyes, but concentrate on getting an overall impression.

### Factors affecting perception

Various factors influence what and how we perceive. Our perceptions are influenced by the ways our bodies are structured to receive and process stimuli from the environment. Our perceptions also reflect our emotions, needs, expectations, and learning.

**Receptors.** Each sensory system, such as vision, hearing, or touch, has its own specialized body parts. These parts are called *receptors,* and they change energies from the environment into nervous impulses. The human eye, for example, has two major kinds of receptors in the *retina* (the light-sensitive part of the eye). These receptors are called *rods* and *cones.* The rods respond to the intensity of light, but not to different frequencies of light (different colours). The cones do respond to different frequencies of light, and are called colour receptors. The rods allow us to see in dim light, and the cones enable us to see colours and sharp detail in bright light. Thus, the particular ways that receptors are structured and function help determine the perceptual effects related to them.

**The brain.** Certain physical and functional features of the brain also determine some aspects of perception. The part of the brain that serves vision has different kinds of cells that respond only under certain conditions of stimulation. Some of these cells respond only when a light goes off. Others respond when a light comes on, but they stop responding if the light stays on. Such cells also are arranged in special ways in the brain, and this fact is related to how we perceive. For example, some cells are arranged in columns or in clusters. Such arrangements are related to how we perceive edges and forms. Experiments suggest that some cells in the brain allow us to perceive movement. Thus, the structure of the brain is an important element in perception.

**Learning, emotion, and motivation.** Much evidence points to the conclusion that early experience, learning, emotion, and motivation are important in defining what and how we perceive. Part of this accumulating evidence comes from experiments that compare how people in different cultures perceive things. The perception of such things as form, colour, pain, and touch may differ from culture to culture, depending on habits and customs, and training of children.

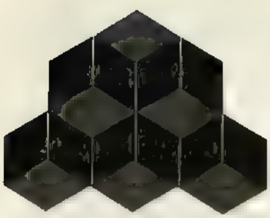
A simple example of how learning can affect perception is provided by reading the phrases inside the two triangles in the illustration on the next page. Did you fail to see the duplicate word in each phrase? Most people do, and some continue to do so even with many repeated readings. In learning to perceive words and sentences, we learn not to perceive each letter and word separately. Instead, we become able to scan the overall pattern and "fill in" the remainder. A poor reader is more likely than a good reader to see the duplicate word in each phrase.

Some illusions are related to learning and past experience. An illusion is not a false perception, as many people believe, but one that is inconsistent with another perception. Since perception does not literally reveal the environment, no sensory system is closer to some absolute truth than any other. We tend to check visual illusions against touch, but touch can involve illusory effects, too. Look at the two triangular patches of grey containing black and white detail in the illustration on this page. If you see the patches as being different shades of grey, you are experiencing an illusion. The patches are the same shade of grey.

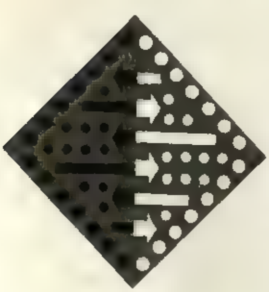
Emotions and motivation can have an important effect on perception. Sometimes a severe emotional disturbance can prevent perception completely, as when emotional shock causes individuals to lose their hearing temporarily. We are more likely to perceive those aspects of our environment that are related to our motives. For example, motivation can affect the perceived characteristics of objects. To hungry people, food may appear larger or more colourful than usual.

**Perceptual effects**


What are the two phrases printed in the two triangles above? Read them carefully. Did you read them correctly the first time?



How many complete cubes do you see in the drawing on the left? Three or five?



How do the two grey triangles on the left compare in brightness? In the drawings below, does the word *World* in the black rectangle appear brighter than the word *Book* in the white rectangle? The text of this article discusses each of the perceptual effects shown here.


### Understanding perception

**Types of perception.** Perception has three levels of complexity: (1) *detection,* (2) *recognition,* and (3) *discrimination.* Detection refers to whether people can sense that they are being stimulated by some form of energy. For example, a light may be so dim they can barely detect its presence. Recognition means being able to identify as well as detect a particular pattern of stimulation. Discrimination means being able to perceive one pattern of stimulation as different from another. For example, a person may hear slight differences between two similar musical tones.

The field of study that deals with levels of perception is called *psychophysics.* Experimental psychologists investigate the relationships between the physical properties of stimulus patterns and the perceived effects of the stimuli. For example, they may study the relationship between sound frequency and the perceived pitch of sound.

**Principles of perception.** There are a number of general principles that help us understand the process of perception. One of the most important is the principle of *closure.* It tells us that we have the general tendency to perceive things as complete and unified. We tend to "fill in" parts that are missing, or parts that conform to an overall impression.

The principle of *constancy* states that despite changes that occur in stimulation, we have a strong tendency to perceive objects as constant in size, shape, colour, and other qualities. For example, an orange will be perceived with its characteristic colour under different kinds of light.

The opposite of the principle of constancy is also important. Sometimes an object or pattern of stimulation will remain constant, but the perceived effect will vary. Look at the grey and black cubes in the illustration on this page. At one moment you will see three complete cubes, and at another you may see five.

Another important principle relates to *perceptual context.* The perception of an object or event depends in part on the *context* (surrounding conditions). Look at the two rectangles containing the words *World Book* in the illustration on this page. The words are printed with the same ink. Do they look the same? Background intensity and colour may affect the colour and intensity of elements upon it. To most people, grey surrounded by black appears brighter and somewhat larger. This effect is called *visual induction.* Notice, too, that the effect is opposite to that observed with the two grey triangles with black and white detail. In this case, the grey with black detail appears darker rather than brighter.

**Related articles** in *World Book* include:

Colour (How we see colour)
Ear (The sense of hearing)
Eye (Parts of the eye; How we see)
Gestalt psychology
Human engineering
Learning disabilities
Nervous system

Optical illusion
Psychology
Senses
Smell
Taste
Touch

**Perceval, Spencer** (1762-1812), was the only British prime minister who met a violent death in office. On May 11, 1812, he was entering the lobby of the House of Commons when he was shot by John Bellingham. Bellingham pleaded insanity at his trial for Perceval's murder. But he was found guilty and hanged on May 18. Perceval had been prime minister for three years during the Napoleonic wars.

Perceval was born in London, and educated at Harrow School and Cambridge University. He was called to the Bar. During the 1790's, he took part in the prosecution of Thomas Paine and other radical leaders. Perceval entered Parliament in 1796. He served as attorney general (1802-1807) and chancellor of the exchequer (1807-1809). In 1809, he succeeded the Duke of Portland as prime minister.

**Perch** is the name given to a family of about 165 different freshwater fish that live in the cooler parts of the Northern Hemisphere. They all have rather long bodies, which may be either rounded or flattened. Their scales are small and tough. They are in the group of bony fish, called *teleosts,* to which most common fish belong. They grow from 15 to 46 centimetres long.

Two species of perch are virtually identical. They are the perch of Eurasia, and the yellow perch of North America. These are deep-bodied fish with a high, spiny *dorsal* (top) fin that is separate fron the second fin. The body is a deep olive green and bronze, with broad vertical black bars on the back and sides. The *pelvic* (lower), anal, and lower tail fins are orange.

The Eurasian and yellow perch live in lakes and slow-flowing rivers. They often hide among aquatic vegetation or under submerged logs and tree roots. When young, they feed on crustaceans and insects, and later on other fish. These perch lay their eggs in long threads among weeds in late spring. They are important angling fish and are a commercially important food fish in Europe. The Eurasian perch has been introduced to many parts of Australia, New Zealand, and South Africa.

Of the many other fish called perch, notable species include the pike perch of southeastern Europe and the Nile perch of Africa.

**Scientific classification.** Most perch belong to the perch family, Percidae. The Eurasian perch is *Perca fluviatilis* and the yellow perch is *P. flavescens.* The pike perch is *Stizostedion lucioperca.* The Nile perch belongs to the family Centropomidae. It is *Lates niloticus.*

See also **Darter; Fish** (picture: Fish of temperate fresh waters); **Skeleton** (diagram).

**Percussion instrument.** See **Music** (Musical instruments); **Orchestra.**

**Percy, Sir Henry** (1364-1403), called Hotspur, was a powerful English nobleman, the son of the Earl of Northumberland. With his father, he helped Henry of Bolingbroke depose Richard II. As a warden of the Scottish Marches, Percy fought the battles of Chevy Chase (1388) and Homildon Hill (1402) against the Scots. In 1403, angry with Henry IV's treatment of himself and his family, Percy rebelled. He was killed at the Battle of Shrewsbury (see **Shrewsbury, Battle of**).

**Peregrine falcon.** See **Falcon.**

**Perelman, S. J.** (1904-1979), was an American writer known for his humorous satires and parodies on contemporary life. Perelman's targets included advertising, best-selling fiction, the Hollywood film industry, and the behaviour of American tourists when they visited other countries.


S. J. Perelman

Sidney Joseph Perelman was born in Brooklyn, New York City. He grew up in Providence, Rhode Island, U.S.A., the setting of several of his works. He helped write the scripts for two of the Marx Brothers' best-known comedies, *Monkey Business* (1931) and *Horse Feathers* (1932). He also wrote a travelogue, *Eastward Ho!* (1977). From 1931 until his death, much of Perelman's work appeared in *The New Yorker* magazine. His selected letters were published after his death in *Don't Tread on Me* (1986).

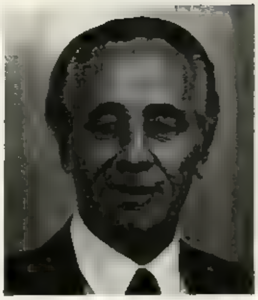
**Perennial** is a plant that lives for more than two years or growing seasons. Sometimes, as in the case of trees, perennials live for many years. Plants whose life span is two years, or two growing seasons, are called *biennials.* Those that live a single year, or one growing season, are called *annuals.* But this classification sometimes varies, because the above-ground parts of some plants are annual, while the parts below the ground are perennial. Some shrubs and herbs, such as the castor-oil plant, are true perennials. But when grown in cold climates, they live only a year. The term *perennial* usually refers to all plants that live more than two years, though some parts may die in winter or in the dry season.

There are two types of perennials: herbaceous and woody. The first type has *herbaceous stems* that die each year, but underground parts that live through the winter. New shoots then grow from the underground parts. Rhubarb and asparagus are examples of such perennials. The other type has *woody stems* that live season after season. These stems increase their diameter by adding tissues (largely new wood) to those of previous seasons. Trees and shrubs are the main woody-stem perennials.

See also **Annual; Biennial; Flower** (Garden perennials); **Gardening** (Cultivating an outdoor garden).

**Peres, Shimon** (1923-     ), became Israel's minister for foreign affairs in 1992. As foreign minister, he was instrumental in bringing about the agreement between Israel and the Palestine Liberation Organization (PLO) which was signed in Washington in September 1993.

Peres served as prime minister in the unity government created by the Labour Party and the Likud bloc in September 1984. The parties formed the government after no party won a majority in the parliamentary elections. The unity government lasted for 50 months. Under the agreement between Labour and Likud, Peres—head of the Labour Party—served as prime minister for 25 months. Yitzhak Shamir, head of Likud, was vice prime minister and foreign minister. Under the agreement, the roles of Peres and Shamir were reversed after 25 months—in October 1986.



Shimon Peres

As prime minister, Peres pledged to withdraw Israeli troops that occupied Lebanon. The troops had invaded Lebanon in 1982, when Likud was in power. In 1985, the Israeli forces withdrew from all of Lebanon except a Security Zone along the Israeli border.

In November 1988, new parliamentary elections were held. Again, no party won a majority. In December, Labour and Likud formed a new coalition government with Shamir as prime minister. Peres remained as vice prime minister and also became finance minister. In March 1990, the coalition government fell apart, and Peres resigned from his posts as vice prime minister and finance minister. Likud and small parties formed a new coalition government in June 1990 with Shamir as prime minister. Peres remained head of the Labour Party until 1992. When Yitshak Rabin succeeded Shamir as prime minister following elections in 1992 Peres joined Rabin's government as foreign minister.

Peres was born in Vishnevo, a small town near Minsk, that was then part of Poland and is now part of Belarus. His family name was Persky. He changed the name to Peres in the 1940's. Peres moved with his family to Palestine in 1934. He later became active in the movement that resulted in the creation of the nation of Israel in Palestine in 1948. In 1950, Peres was sent to the United States as leader of a defence ministry delegation. While there, he studied at New York University and Harvard University. He returned to Israel in 1952.

Peres has served in the Israeli *Knesset* (parliament) since 1959. He helped form the Labour Party in 1968 and became the party's head in 1974. Peres was minister of defence from 1974 to 1977.

**Pérez de Cuéllar, Javier** (1920- ), is a diplomat from Peru who served as the fifth secretary-general of the United Nations (UN) from 1982 to 1991. He replaced Kurt Waldheim of Austria, who had held the office since 1972. Pérez de Cuéllar was the first secretary-general from Latin America. He served two five-year terms of office. He was succeeded in January 1992 by Boutros Boutros-Ghali of Egypt.

Pérez de Cuéllar was born in Lima, Peru. He received a law degree at the Catholic University in Lima in 1943 and entered Peru's foreign service in 1944. He served as Peru's ambassador to Switzerland, Venezuela, and the Soviet Union and, in 1971, became Peru's delegate to the UN. In 1975, he began serving in the Secretariat, which manages the UN's daily business. As secretary-general, Pérez de Cuéllar worked to improve the UN's administrative efficiency. He also was active in negotiations on conflicts in Afghanistan, Central America, Cyprus, the Falkland Islands, and the Persian Gulf. In 1988, he helped negotiate a truce in a war between Iran and Iraq.

**Perfume** is a substance made of natural or *synthetic* (artificially created) materials, or a combination of both. These materials are combined by a *perfumer* (a maker of perfumes) to produce a pleasing fragrance.

People use perfumes in many ways to create a pleasant odour. They apply paste and liquid perfumes to their bodies and clothing. They use lipsticks, face and body lotions and powders, and other cosmetics that contain perfume. By far the largest amount of perfume is used in soaps, especially bar soaps. Industrial *odorants* (low-priced, scented substances) are added to some products to hide unpleasant odours and make the products attractive to buyers. Paper, plastic, and rubber products are often treated with odorants. Since ancient times, plants and plant products with pleasing odours have been burned as incense during religious services.

All liquids used for body scenting, including colognes and toilet waters, are sometimes called perfumes. But *true perfumes*—called *extracts* or *essences*—contain a greater amount of perfume oils and are more expensive. Most perfumes consist of 10 to 20 per cent perfume oils dissolved in alcohol. Colognes contain 3 to 5 per cent perfume oils dissolved in 80 to 90 per cent alcohol, with water making up the balance. Toilet waters have about 2 per cent of perfume oils in 60 to 80 per cent alcohol. The balance consists of water.

### How perfumes are made

The composition of a perfume depends largely on its intended use. Most expensive body perfumes contain rare flower oils from many parts of the world. Perfumes used in soapmaking come from low-cost materials. Industrial odorants also consist mainly of low-cost fragrances. Many perfumes are blends of flower and plant oils, animal substances, synthetics, alcohol, and water.

**Plant substances.** Fragrant plants have tiny *sacs* (baglike parts) that make and store the substances that give them their pleasant odour. These substances are called *essential oils.* Essential oils taken from flower petals are used in the most delicate and expensive perfumes. Essential oils are also found in other parts of plants. They may come from the bark, buds, leaves, rinds, roots, wood, or from whole plants. Plants whose oils are used extensively in perfumes include the cinnamon, citronella, geranium, jasmine, lavender, patchouli, rose, rosemary, sandalwood, and tuberose.

Much essential oil is *extracted* (obtained) from plants by *steam distillation.* The first step in this process is to pass steam through the plant material. The essential oil turns to gas, which is then passed through tubing and cooled to make it liquid again. Essential oil is obtained from some flowers by boiling the petals in water, rather than by passing steam through them.

*Solvent extraction* is an important way of obtaining essential oils from flowers. The petals are dissolved in a *solvent* (liquid that can dissolve other substances). The solvent is distilled from the solution, leaving a waxy material that contains the oil. This material is placed in ethyl alcohol. The essential oil dissolves in the alcohol and rises with it to the top of the wax. Heat is applied, and the alcohol evaporates, leaving a highly concentrated form of perfume oil.

*Enfleurage* is another method of extracting flower oils. Glass plates are covered with fat, and flower petals are spread over the fat. The fat absorbs the oil from the petals, forming a greasy *pomade.* The pomade is treated with alcohol to dissolve out the oil.

**Animal substances** slow the evaporation of perfume

oils, and make the fragrances long-lasting. For this reason, they are often called *fixatives.* Perfume ingredients from animals include castor, from the beaver; civet musk, a fatty substance from the civet; musk, from the male musk deer; and ambergris, a waxy substance from the sperm whale.

**Synthetic substances** account for the largest amount of materials used in the perfume industry. The raw materials for these substances may be obtained from natural sources, petrochemicals, or coal tar. Some synthetic materials have the same chemical makeup as naturally occurring materials. Others are different from any material found in nature. Many synthetic odours have been developed throughout the world to meet the increasing demand for perfumes and to add to the creative development of the perfume industry.

### History

Ancient peoples burned fragrant resins, gums, and woods as incense at religious ceremonies. They enjoyed the pleasant smell of the smoke from the burning incense. The word *perfume* comes from the Latin words *per,* meaning *through,* and *fumus,* meaning *smoke.*

Perfumes have been found in the tombs of Egyptian *pharaohs* (rulers) who lived more than 3,000 years ago. The Egyptians soaked fragrant woods and resins in water and oil, and then rubbed their bodies with the liquid. They also *embalmed* (preserved) their dead with these liquids. The ancient Greeks and Romans learned about perfumes from the Egyptians.

For hundreds of years, perfume making was chiefly an Oriental art. In the early 1200's, the crusaders brought perfume from Palestine to England and France. By the 1500's, perfumes had become popular throughout Europe. Synthetic chemicals have been used extensively in perfumes since the late 1800's.

**Related articles** in *World Book* include:

| | | |
|---|---|---|
| Ambergris | Flower (picture: Perfumes) | Orrisroot |
| Attar | | Patchouli |
| Citronella | Frankincense | Petitgrain oil |
| Civet | Musk | Rosemary |
| Extract | Myrrh | Tuberose |

**Pergamum** was a great ancient city in western Asia Minor (now Turkey). It was probably founded several hundred years before it became an important centre of Greek culture during the 200's B.C. The kings of the Attalid dynasty ruled Pergamum after 263 B.C. They invited philosophers, writers, and artists to the royal court and established an outstanding library in the city. They also encouraged trade and promoted the manufacture of brocade textiles and parchments. Sculptors from Pergamum developed a distinct style, which they employed in creating a magnificent altar dedicated to Zeus, king of the Greek gods. The city reached the height of its splendour during the reign of Eumenes II, between 197 and 159 B.C.

The Attalids were allied with Rome, and Pergamum came under Roman control in 133 B.C. The Romans made Pergamum a major centre of industry and education. The city had a medical school and a number of beautiful buildings. Galen, a great doctor, lived in Pergamum in the A.D. 100's. The city was also a centre of early Christianity.

See also **Library** (Libraries of animal skins).

**Pergolesi, Giovanni Battista** (1710-1736), was an Italian composer. He was mainly interested in writing operas, both serious and comic. In his time, comic operas were performed as short insertions between the acts of serious operas.

Pergolesi was among the first composers to write comic scenes with dialogue in local dialect. His most significant work, the short comic opera *La Serva Padrona,* was first performed between the acts of his serious opera *Il Prigioner Superbo* (1733). This comic interlude marked the beginning of the opera style called *opera buffa.*

Pergolesi was born in Iesi, Italy, and studied music in Naples. He composed many religious works, of which the most famous was *Stabat Mater* (1729?). He died of tuberculosis at 26.

**Pericardium.** See **Heart** (Parts of the heart).

**Pericles** (490?-429 B.C.) was a Greek statesman whose name was given to the greatest period in the history of ancient Athens. He was the leader of the Athenian government for more than 30 years, and the Age of Pericles came to stand for all that was highest in the art and science of the ancient world.

Pericles was born in Athens, a member of a high-ranking noble family. He was educated by the greatest philosophers of his day. His mother was a niece of Cleisthenes, a statesman who had made many democratic reforms in the Athenian government (see **Cleisthenes**). Cleisthenes had given the power for governing the city to the assembly and popular courts. But because officials then received no pay, the poor could not afford to hold office. After Cleisthenes' death, the *Areopagus,* a council of prominent citizens, took back its power over the city.

Pericles was determined to continue the reforms that his great-uncle had initiated. Pericles entered politics with the democratic popular party. He and Ephialtes, the leader of this party, worked together to limit the power of the Areopagus. However, Pericles found himself opposed by Cimon, the leader of the aristocratic party. Pericles managed to have his rival *ostracized* (banished) for favouring the Spartans.

**Athenian leader.** In about 460 B.C., Ephialtes was killed. Pericles became leader of the popular party and the most powerful person in the state. He made many changes as head of the state. Public officials had never been paid before, but Pericles introduced salaries, first for the elected officials called *archons,* and later for all officers. According to Aristotle's *Constitution of Athens,* as many as 20,000 persons were on the public payroll. In 457 B.C., Pericles made his greatest democratic reform. The common people were allowed to serve in any state office.

Pericles wanted to consolidate his state's strength and to make Athens the most powerful state in Greece. He tried to expand the power of Athens by foreign conquest. Athenian troops fought in Egypt, Boeotia, and the Aegean Islands. This angered Sparta, and the two states broke off friendly relations.

**War with Sparta.** Pericles' wars were not all successful, and Cimon was allowed to return from exile to lead the armies. Cimon fought successfully against Persia, and Athens made a favourable peace with that country in 449 B.C. Three years later, Athens signed a 30 years'


**Pericles** was a Greek statesman. He was leader of the Athenian government for more than 30 years.

peace treaty with Sparta allowing Athens to keep Aegina, Euboea, and the cities of the Delian League. But Pericles feared there could be no peace with Sparta, for the Spartans were jealous of Athenian power. To prepare for a possible attack, Pericles improved the fortifications around Athens.

The Athenians had moved the treasury of the Delian League from Delos to Athens during the war with Persia. Pericles persuaded the Athenians to use this money and the money paid by the subject states to build up the Athenian navy and to beautify Athens. He employed the finest architects and sculptors to build and decorate the temple of Athena Nike, the Propylaea, the Parthenon, and many other structures for the glory of Athens. The state enjoyed prosperity, and literature and philosophy flourished.

The Peloponnesian confederacy, headed by Sparta, declared war on Athens in 431 B.C. Pericles persuaded the Athenians to adopt a new and difficult strategy. He called all the people of the surrounding districts into the city and allowed the Spartans and their allies to lay waste to the surrounding districts as they pleased. Pericles continued to build up the navy with the hope that Athens could defeat the Spartans with sea power. In 430 B.C., a plague broke out in the city, and many people died. The Athenians began to blame Pericles for all their troubles, and for a short while removed him from power. But he was soon restored to office. Pericles died of the plague during the war.

See also **Athens** (The Acropolis and its buildings); **Parthenon; Peloponnesian War; Sparta.**

**Peridot** is a transparent gem that is almost always some shade of green because of its iron content. Peridots are a variety of a common rock-forming mineral called *olivine.* Jewellers cut and polish the highest-quality peridot stones so that each gem has many flat surfaces called *facets.* Faceted peridots are used in all types of fine jewellery. Jewellers cut lesser-quality peridots into a rounded style called *cabochon,* or polish them with abrasives in a process called *tumbling.* These gems are used in costume jewellery and decorative objects. Peridot is one of the two birthstones for August.

Peridots have been known since Biblical times. The earliest source of peridots was Jazirat Zabarjad (St. John's Island), off the Egyptian coast in the Red Sea. Burma is a source of very large peridots.

See also **Gem** (picture).

**Perigee.** See **Orbit.**

**Perihelion** is the position of a planet or comet when it is closest to the sun. In the Northern Hemisphere, the earth is at perihelion at midwinter. At this time, the sun shows a larger diameter, but this difference is only 1.7 per cent of the sun's average size. A person cannot see the difference without instruments. When a planet or comet's distance from the sun is greatest, it is at *aphelion.*

**Perimeter.** See **Algebra** (Writing formulas).

**Period,** in geology. See **Earth** (History).

**Period, Menstrual.** See **Menstruation.**

**Periodic table,** also called *periodic chart.* See **Element, Chemical; Mendeleev, Dmitri Ivanovich.**

**Periodical.** See **Magazine; Trade publication.**

**Periodontitis** is a disease of the gums and of the bone that supports the teeth in their sockets. Periodontitis, also called *pyorrhoea alveolaris,* is the chief cause of the loss of teeth after the age of 35.

The most common form of periodontitis results from the build-up of *plaque* on the teeth and gums. Plaque is a sticky mixture of food particles and bacteria. The bacteria and their waste products irritate the gums and produce *gingivitis,* an inflammation of the gums (see **Teeth** [Periodontal diseases]). If gingivitis is not treated, the gums become swollen and bleed easily, and in time they may recede from the teeth. The bacteria then attack the connective fibres that line the teeth sockets, and pus forms in the narrow pockets between the teeth. The spreading infection destroys the fibres and surrounding bone that hold the teeth in their sockets. As periodontitis progresses, the teeth become loose and may eventually fall out.

Periodontitis is curable in its early stages. A dentist should be consulted if the gums are red and tender and bleed easily. Treatment consists largely of removing plaque, grinding off rough surfaces of the teeth, and surgically removing the diseased gums and bone.

Proper care of the teeth, including daily brushing and use of *dental floss* (a thin, waxed thread that comes in a roll), helps prevent the disease.

See also **Dentistry** (Periodontics).

**Periosteum.** See **Bone** (Structure); **Membrane.**

**Peripatetic philosophy** was established by the Greek philosopher Aristotle in the 300's B.C. The word *peripatetic* may be traced to either of two Greek words, one meaning *to walk* and the other meaning *a covered walk.* When Aristotle lectured to his followers, he walked about under the *porticoes* (shaded walks) of the Lyceum at Athens. Peripatetic philosophy got its name from this custom.

Aristotle was a pupil of Plato, who felt that a person could reach the truth only by logic and reason. Plato taught that the world of *appearances* (everyday life) did not accurately represent the real world, which consisted of true ideas. Aristotle believed that reality could not be separated from appearance in this way. He felt that to know reality, a person had to study appearances. Aristotle held that everything except pure form (God) and pure matter was a combination of both form and matter.

See also **Aristotle.**

**Periscope** is an optical instrument with which a person can make observations from a distance or around corners. In its simplest form, it consists of a long tube with a reflecting mirror or prism at each end. These reflecting surfaces are exactly parallel to one another, and are arranged at an angle of 45 degrees to the axis of the tube. Some periscopes have lenses to enlarge the image viewed through the tube.

Periscopes are important in weapons of war, such as submarines and tanks. Officers on a submerged submarine can observe events on the surface, looking for targets or navigating, by peering into their periscopes. Tank commanders can direct action in a battle and remain inside their tanks with the aid of periscopes.

The periscope on a submarine can move up and down, and can be rotated to look in a complete circle. Submarines often cruise at *periscope depth,* with only the periscope above the water.

Not all periscopes are used in warfare. The longest periscope in the world, 27 metres long, protects workers at the Idaho National Engineering Laboratory near Idaho Falls, Idaho, U.S.A. Scientists use the periscope to observe nuclear reactors in operation.

See also **Submarine.**

**Peritoneum.** See **Peritonitis.**

**Peritonitis** is an inflammation of the *peritoneum,* the thin membrane that lines the abdominal cavity. It is an illness that can cause death. The peritoneum may become inflamed if it is attacked by bacteria or irritated by a foreign substance.

Peritonitis may be either *chronic* or *acute. Chronic peritonitis* lasts for a long time. It can cause inflamed tissues to grow together. As a result, the intestines may not work properly. People suffering from tuberculosis sometimes develop chronic peritonitis.

*Acute peritonitis* occurs suddenly. The inflammation may affect a small part of the peritoneum, or it may involve a large area. It starts with fever, chills, vomiting, and severe abdominal pain. The abdomen becomes rigid and swells. The pulse becomes rapid, and the number of white blood cells increases.

Acute peritonitis is caused by bacteria that escape from such organs of the body as the alimentary canal, Fallopian tubes, or pancreas. Bacteria can escape from an organ such as the appendix if the organ is so badly infected that it tears open. This may follow such conditions as gangrene of the intestine, a damaged bowel, or an infected pancreas.

Peritonitis requires prompt medical care. Antibiotics and other drugs are used to treat any infection and control pain. If an organ breaks open, an operation is usually performed as soon as possible to close the opening and drain the infection.

**Periwig.** See **Wig.**

**Periwinkle** is the name of about a dozen species of small, evergreen flowering shrubs and ground-cover plants. They are best known for the intense blue or purple-blue colour of their flowers. Periwinkles are native to Europe, Africa, and Asia, and have been introduced to many other countries as ornamental plants.

The *greater periwinkle* and *lesser periwinkle* are low, spreading *undershrubs* (shrubs that grow under bushes). They have dark green, broad, spear-shaped, leathery leaves. They are usually planted in shady positions in parks and gardens. The *Madagascar periwinkle* is a tropical species with rose pink flowers. An extract from it stops the growth of certain types of human tumours and is used as an anticancer drug.

**Scientific classification.** Periwinkles belong to the family Apocynaceae. The greater periwinkle is *Vinca major;* the lesser periwinkle is *V. minor;* the Madagascar periwinkle is *V. rosea.*

**The lesser periwinkle** grows in shady places, such as on banks and in woods. It has thin wiry stems, narrow leaves, and purple-blue flowers.

**Periwinkle** is the common name for several species of small snails of the seacoast. The best known is the common periwinkle of northern Europe and the Atlantic coast of North America. This periwinkle clings to rocks between high and low tide levels. Its thick, spiral shell is greyish-brown or nearly black. It may reach a length of about 4 centimetres.

Some species of perwinkle are found only at certain levels of the sea shore. For example the small perwinkle lives only in the upper splash zone.

**Scientific classification.** Periwinkles are in the periwinkle family, Littorinidae. The common periwinkle is *Littorina littorea* and the small periwinkle is *L. neritoides.*

**Perjury** is a crime in which a person swears or affirms to tell the truth in a court of law or in an administrative or legislative proceeding, and then deliberately tells a lie. In most countries, the lie is perjury only if it has a direct bearing on the issue before the court, tribunal, or legislative body. An unintentional misstatement is not considered perjury.

Aiding and *abetting* (encouraging) someone to commit perjury has the same punishment as perjury. In some countries the English common-law offence of *subornation of perjury* (procuring someone to take a false oath) still exists as a separate offence.

See also **Contempt; Evidence; Trial.**

**Perkin, Sir William Henry** (1838-1907), a British chemist, founded the aniline dye industry. At the age of 18, Perkin discovered a violet-coloured dye while he was trying to make synthetic quinine. He and his father set up a factory to make the dye commercially. Perkin's other discoveries included synthetic tartaric acid, used in effervescent beverages; cinnamic acid, used in medicine and perfume; and coumarin, used in perfume and food flavouring. Perkin also devised a method for the formation of unsaturated fatty acids and worked on the polarization of light. He was born in London, and attended the Royal College of Chemistry.

See also **Aniline.**

**Perkins, Charles** (1936- ), an Australian Aboriginal leader, was the first Aborigine to graduate from a university. He received his degree from the University of Sydney in 1965. Perkins was born near Alice Springs. He was sent to school in Adelaide at the age of 9. Later, he played professional soccer. In 1961, he decided to go to university. After graduation, Perkins began working for the rights of his people. In 1984, he became head of the Department of Aboriginal Affairs. Perkins resigned from this position in 1989, after being cleared of allegations of corruption and mismanagement.

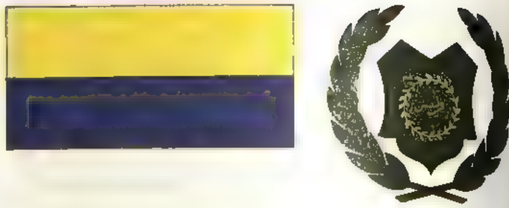
**Perlis** is the smallest state in Malaysia. It lies in the far northwest of Peninsular Malaysia on the border with Thailand. The state capital is Kangar.

**People and government.** Over 78 per cent of the state's population are Malay. About 17 per cent are Chinese, and about 3 per cent are Indian. The head of state of Perlis is a *raja,* or sultan, who is a hereditary ruler. The state assembly has 14 seats. See also **Malaysia, Government of.**

**Economy.** Most of the people work in agriculture. The major crop is rice, which grows well on low-lying, highly fertile land which dominates Perlis. There are a number of rubber plantations, and sugar cane is also a plantation crop. Many villagers grow vegetables, fruits, and coconuts. In the coastal towns of Kuala Perlis and Kuala Sanglang many people earn their living from fishing. Since the 1970's, there has been some development of manufacturing and processing in the state. There is some tin mining in the north, and the state's plentiful limestone is used for cement manufacture.

**Facts in brief about Perlis**

**Population:** *1991 census*—184,070.
**Area:** 795 km².
**Capital:** Kangar.
**Chief products:** *Agriculture*—rice, rubber.



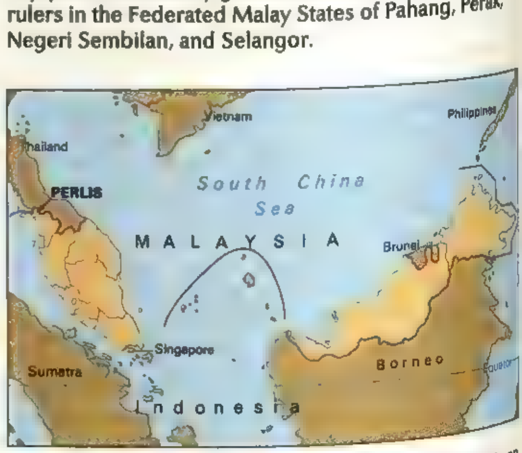
**The flag of Perlis** has two horizontal stripes. Yellow stands for the ruler of the state and blue stands for the people. The emblem of Perlis, *right,* features a circle of rice on a shield within a wreath of rice. Rice is the state's main product.

Tourism is also becoming more important. The Langkawi group of islands, about 30 kilometres off the coast from Kuala Perlis, are being developed as a holiday resort. They have many beautiful beaches. To encourage tourism the national government has given Langkawi the status of a duty-free zone.

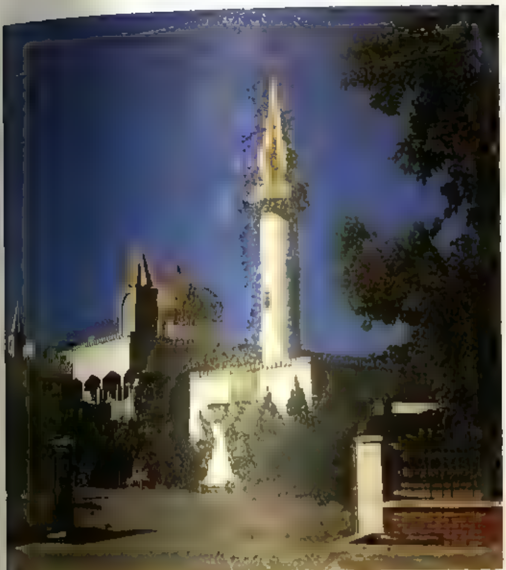
**Land.** The land is mainly low-lying and fertile. Away from the coast, the land rises to the low mountains of the Nakawn Range, which marks the border with Thailand. In northern Perlis there are major outcrops of limestone. In many parts, the limestone is more than 630 metres thick, and contains many large caves. The Perlis and Arau rivers flow through the state and drain into the Strait of Malacca.

**History.** Perlis was originally part of Kedah. In 1821 Thai forces attacked Kedah and brought it under their authority. In 1839 the Thais divided the state into four, with Perlis as the northern division. Perlis was then a separate dependency of Thailand. Its ruler was a Malay chief who was willing to cooperate with the Thais.

Toward the end of the 1800's, the authority of the Thai rulers began to weaken. At the same time, the ambitions of the British administrators in Singapore and Kuala Lumpur grew stronger. Under an Anglo-Thai treaty in 1909, the British took control of Perlis. During the British colonial period, Perlis was linked with Kedah, Kelantan, Terengganu, and Johor to form what was called the *Unfederated Malay States.* The Malay rulers in these states enjoyed considerably greater freedom of action than the rulers in the Federated Malay States of Pahang, Perak, Negeri Sembilan, and Selangor.




**Perlis** is a small state in the northwest of Peninsular Malaysia on the border with Thailand.



Arau, near Kangar, is the royal capital of Perlis. It has an *istana* (royal palace) and the royal mosque, *above.*

However, economic growth was slow. Unlike Malay states to the south, Perlis did not have large scale immigration by Chinese or Indian workers. Perlis has a much higher proportion of Malay people than other Malaysian states.

In 1942, the Japanese drove the British from Malaya. Perlis once again came under the authority of Thailand. But with the defeat of Japan in 1945 and the restoration of the colonial administration, the British again took control. In 1948 Perlis became part of the Federation of Malaya. In 1957, Malaya achieved independence from British rule. As part of independent Malaya and later of Malaysia, Perlis achieved only limited economic and political importance. But its extensive border with Thailand gave it military importance, especially during the 1960's and 1970's when remnants of the Malayan Communist Party fled across the Thai-Malaysian border.

See also **Malaysia.**

**Perlman, Itzhak** (1945- ), is a noted Israeli violinist. He won fame for his rich tone, technical mastery, and expressive playing. An attack of polio left Perlman permanently disabled when he was 4 years old. Because of his handicap, Perlman walks with crutches and leg braces and performs sitting down.

Perlman was born in Tel Aviv, Israel. He began playing publicly before he was 10 years old. In 1958, he was a winner in an Israeli talent competition. He and other winners travelled to the United States to appear on television and make a concert tour. After the tour, he and his parents settled in New York City so that he could continue his musical training there.

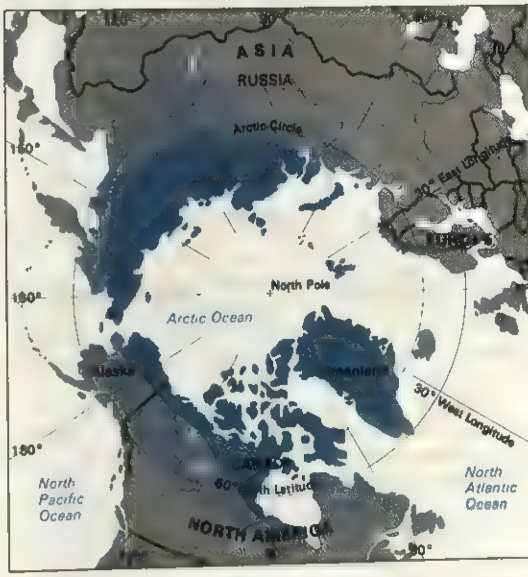
**Permafrost** is ground that is permanently frozen. Such ground may consist of rock, sand, or soil. Usually, ice surrounds the rocks and earth particles and binds them into a solid mass. Permafrost may be *continuous, discontinuous,* or *sporadic.* Continuous permafrost occurs in regions where the climate is cold enough to freeze all the land. Sometimes, small areas of unfrozen land occur within larger, permanently frozen areas. This type of land is called discontinuous permafrost. Sporadic permafrost refers to small areas of permanently frozen land that exist within an unfrozen region.

**Permafrost**

This map shows the extent of permafrost in the Northern Hemisphere. Permafrost underlies much of Alaska, Canada, Greenland, and Russia.

Region of continuous permafrost

Region of both permafrost and unfrozen ground




Permafrost occurs in about a fifth of the world's land. It may occur in all regions with an average annual temperature of 0° C or below. In some places, the ground is frozen to depths of over 900 metres.

Permafrost may thaw from heat present in buildings and other structures. In summer, a surface layer of permafrost called the *active layer* may thaw if temperatures are warm enough. The active layer is usually very muddy because the moisture cannot penetrate the permafrost beneath it.

**Permalloy** is a nickel-iron alloy that is easy to magnetize. It can be magnetized by wrapping an insulated wire around it and sending an electric current through the wire. Permalloy loses its magnetism when the current is turned off. When a weak alternating current is sent through a coil wound around a Permalloy bar, it produces a strong, alternating magnetic field in the material. For this reason, Permalloy is an ideal material for use as the core of the low-power inductors and transformers used in communication engineering. The term *Permalloy* comes from the two words *permanent* and *alloy.* Permalloy was developed in 1916 by G. W. Elmen, an engineer for the Western Electric Company of the United States. Today, scientists are developing new alloys that have better magnetic properties than Permalloy.

**Permian Period.** See **Earth** (table: Outline).

**Permutations and combinations** are names that mathematicians use for certain groups of objects or symbols. *Permutations* are *ordered arrangements* of a set of objects. For example, ABC, ACB, and BAC are three permutations of the set of symbols A, B, and C. *Combinations* are those groups that include the same objects *regardless of the order in which they are arranged.* The sets ABC, ACB, and BAC are all examples of the same combination. Sets such as ABC, ABD, and ACD are examples of different combinations.

The branch of mathematics that includes permutations and combinations is called *combinatorics.* Combinatorics has many uses, including the routing of telephone calls through cables and the scheduling of production in factories. With the use of computers, it has become an area of active research, as computers can rapidly perform many repetitive calculations.

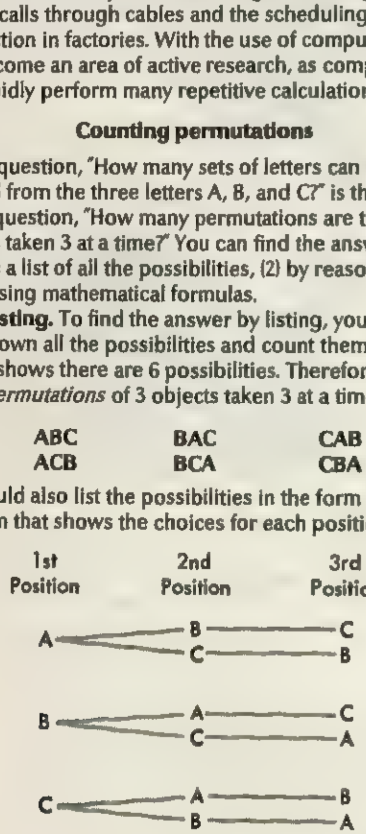
### Counting permutations

The question, "How many sets of letters can be formed from the three letters A, B, and C?" is the same as the question, "How many permutations are there of 3 objects taken 3 at a time?" You can find the answer (1) by making a list of all the possibilities, (2) by reasoning, and (3) by using mathematical formulas.

**By listing.** To find the answer by listing, you merely write down all the possibilities and count them. The list below shows there are 6 possibilities. Therefore there are 6 *permutations* of 3 objects taken 3 at a time.

| | | |
|---|---|---|
| ABC | BAC | CAB |
| ACB | BCA | CBA |

You could also list the possibilities in the form of a tree diagram that shows the choices for each position:




The diagram again shows that 6 permutations can be formed.

**By reasoning.** You could also find the number of permutations by reasoning. For the first position, you have 3 possible choices, A or B or C. With each of these choices, you have only 2 possible choices left for the second position, and $3 \times 2 = 6$. With each of these 6 possibilities, you have 1 possible choice for the third position, and $6 \times 1 = 6$. Therefore, the number of possible sets of letters is $3 \times 2 \times 1 = 6$.

Using reason is better than just listing the permutations because reasoning accounts for every possibility. In listing, you might forget to include some possibilities, especially if you had a large number of objects.

Suppose, for example, that you had 26 letters instead of only the letters A, B, and C, and that you were asked to find the total number of sets of *3* letters that could be formed. Listing all the possibilities would be difficult and tedious. But finding the answer by reasoning would be easy. With every one of the 26 possible choices for the first position, there would be 25 choices for the second position. This makes a total of 650 possibilities ($26 \times 25 = 650$). With each of these 650 choices, there would be 24 letters remaining as possible choices for the third position, making a total of 15,600 possible combinations ($650 \times 24 = 15{,}600$). The total number of permutations is therefore $26 \times 25 \times 24 = 15{,}600$.

The above example illustrates the *multiplication principle* for permutations: *If the first position can be filled in* n *ways, and the second can be filled in* n−1 *ways, and the third in* n−2 *ways, then the total number of permutations in the three positions is* $n \times (n-1) \times (n-2)$.

Suppose you had only A's, B's, and C's, but at least 3 of each. How many sets of 3 initials could you form? (The sets would include AAA, AAB, ABB, and so on.) In this example, each position could be filled in 3 different ways, and so you could calculate the answer: $3 \times 3 \times 3 = 27$ sets. With 26 letters and at least 3 of each, you could form $26 \times 26 \times 26 = 17{,}576$ sets.

**By using symbols and formulas.** In mathematical terms, the number of permutations of *n* things taken *r* at a time is represented by the symbol $P^n_r$ (sometimes written $_nP_r$). Using this symbol, you can express the answers to permutation problems as follows:

3 things (such as A, B, and C) taken 3 at a time

$$P^3_3 = 3 \times 2 \times 1 = 6$$

26 things taken 3 at a time

$$P^{26}_3 = 26 \times 25 \times 24 = 15{,}600$$

*n* things taken *r* at a time

$$P^n_r = n(n-1)(n-2)\ldots[n-(r-1)]$$

The last expression is the general formula. The bracketed quantity, $[n-(r-1)]$, means *n* minus the quantity $(r-1)$. Algebraically, this quantity is the same as $(n-r+1)$. This quantity tells you at what point to stop writing successive multipliers in the formula. For example, if *n* is 26 and *r* is 3, then $(n-r+1) = 26-3+1 = 24$ and so the multipliers for $P^{26}_3$ are $26 \times 25 \times 24$.

### Solving combination problems

If you had 4 books, how many sets of 3 books could you form? This question is the same as the question, "How many *combinations* are there of 4 things taken 3 at a time?" Suppose, for example, that the 4 books were written respectively by Adams, Beery, Cole, and Doe. If you chose books by Adams, Beery, and Cole, your reading material would be the same regardless of the order in which you read the books. Thus, there is only 1 *combination* of these 3 books taken 3 at a time. How many other 3-book combinations could you make from the 4 books? As in the permutation problem above, you can find the answer (1) by listing the possibilities, (2) by reasoning, and (3) by using mathematical formulas.

**By listing.** For simplicity, represent the 4 books by the letters A, B, C, and D. Write down several groups of these 4 letters, and then cross out one letter at a time, always leaving a group of 3. You would cross out a different letter each time so that the remaining group would always be a different combination.

$$\begin{aligned} ABC\cancel{D} &\longrightarrow ABC \\ AB\cancel{C}D &\longrightarrow ABD \\ A\cancel{B}CD &\longrightarrow ACD \\ \cancel{A}BCD &\longrightarrow BCD \end{aligned}$$

The list shows that there are 4 possible combinations.

**By reasoning.** A knowledge of permutations enables you to arrive at the answer in the following way. You can select any 3 of the books in 6 different orders, for example, ABC, ACB, BAC, BCA, CAB, CBA. But these 6 *permutations* represent only a single *combination.* You can conclude that there are 6 permutations for *each* different combination of 3 books. Therefore, the total number of permutations must be equal to 6 times the number of possible combinations. Likewise, the number of possible combinations must be equal to the total number of permutations divided by 6. The total number of permutations of 4 books taken 3 at a time is

$$P_3^4 = 4 \times 3 \times 2 = 24$$

The number of permutations for each combination of 3 books is

$$P_3^3 = 3 \times 2 \times 1 = 6$$

Therefore, the number of possible combinations is $24 \div 6 = 4$.

Suppose you want to count how many combinations of 3 different letters could be made from the 26 letters of the English alphabet. In this article on counting permutations, we calculated that the total number of permutations of 26 letters taken 3 at a time is $26 \times 25 \times 24 = 15{,}600$. We also calculated that the number of permutations for each combination of 3 letters is $3 \times 2 \times 1 = 6$. Therefore, the number of possible combinations of the 26 letters is $15{,}600 \div 6 = 2{,}600$.

**By using symbols and formulas.** The number of combinations of $n$ objects taken $r$ at a time is represented by the symbol $C_r^n$ (sometimes written $\binom{n}{r}$ or ${}_nC_r$). In the book example that we have been considering, the number of possible combinations can be expressed and calculated as follows:

$$C_3^4 = \frac{P_3^4}{P_3^3} = \frac{4 \times 3 \times 2}{3 \times 2 \times 1} = \frac{24}{6} = 4$$

The general formula for combinations is

$$C_r^n = \frac{P_r^n}{P_r^r} = \frac{n(n-1)(n-2)\ldots(n-r+1)}{r(r-1)(r-2)\ldots3 \times 2 \times 1}$$

For example, if $n=6$ and $r=4$,

$$C_4^6 = \frac{6 \times 5 \times 4 \times 3}{4 \times 3 \times 2 \times 1} = 15$$

Mathematicians simplify the formula for $C_r^n$ by using *factorial notation* to represent the product of a positive whole number with all the positive whole numbers less than itself. *Factorial 3* means $3 \times 2 \times 1$, and it is written $3!$. Likewise, $4!$ means $4 \times 3 \times 2 \times 1$. Permutation formulas can therefore be simplified as follows:

$$P_3^3 = 3! \qquad P_4^4 = 4! \qquad P_r^r = r!$$

The simplified combination formula is

$$C_r^n = \frac{n(n-1)(n-2)\ldots(n-r+1)}{r!}$$

Mathematicians simplify the above formula even more and write it as follows:

$$C_r^n = \frac{n!}{r!(n-r)!}$$

The last two formulas are the same because

$$\frac{n!}{r!(n-r)!} = \frac{n(n-1)(n-2)\ldots(n-r+1)(n-r)(n-r-1)}{r!(n-r)(n-r-1)} \cdot \frac{(n-r-2)\ldots3 \times 2 \times 1}{(n-r-2)\ldots3 \times 2 \times 1}$$

All factors in this expression can be divided out except for $n(n-1)(n-2)\ldots(n-r+1)$ in the numerator and $r!$ in the denominator. These are the same factors that appear in the original combination formula.

With the two forms of the combination formula, you can calculate the number of possible combinations in two ways. For example, if you had 5 books from which to choose a set of 3, you could find the number of combinations as follows:

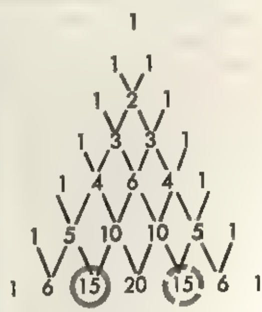
$$C_3^5 = \frac{5 \times 4 \times 3}{3 \times 2 \times 1} = 10$$

$$C_3^5 = \frac{5 \times 4 \times 3 \times 2 \times 1}{(3 \times 2 \times 1)(2 \times 1)} = 10$$

If you divide out factors in the numerator and denominator of the above expressions, you will see that they are identical. See also **Factor.**

### History

The real development of mathematical thought about permutations began in the 1600's with the development of the theory of probability. About this time, the French mathematician Blaise Pascal discovered an interesting device for computing combinations. The device, called *Pascal's triangle,* is shown in the illustration. Pascal constructed the triangle so that each number was the sum of the two numbers above it. The numbers, called elements, are arranged in *rows.* Each element has a *place* in a row determined by counting from left to right. Thus, 20 appears in the 4th place of the 7th row of the triangle.




Pascal found that the element in the $(r+1)$th place of the $(n+1)$th row is the same as the number of combinations of $n$ things taken $r$ at a time $(C_r^n)$. If $n$ is 6 and $r$ is 2, the number of combinations is given in the 7th row, the 3rd place (15, as circled). But 15 also appears in the 5th place of the 7th row (dashed circle). Because the triangle is symmetrical, the element that is in the $(r+1)$th place of the $(n+1)$th row is always the same as the element in the $(n-r+1)$th place of that row. Therefore, $C_r^n = C_{n-r}^n$. If $n$ is 6 and $r$ is 2, the same number of combinations is possible if the objects are taken 2 or 4 at a time.

**Pernicious anaemia.** See Anaemia.

**Perón, Eva Duarte de** (1919-1952), was the second wife of President Juan Perón of Argentina. Eva, also called Evita, helped Perón rise to power and became one of the most famous women of her day.

**Eva Perón**

Eva Perón was born Maria Eva Duarte in Los Toldos, near Buenos Aires. Her family was poor, and she went to Buenos Aires at the age of 15 to become an actress. She met Perón in 1944 when she was a successful radio actress, and married him in 1945. In 1946, he became president of Argentina. Eva began to serve as his contact with the country's trade unions. In 1948, she established a women's branch of Perón's political party.

In 1951, Eva tried to join her husband in the government by running for vice president. But leading Argentine military officers feared that in time she might succeed to the presidency, and they blocked her candidacy. The officers opposed her mainly because they could not accept the idea of a woman becoming the nation's president and top military commander. Eva died of cancer in 1952.

See also **Perón, Juan Domingo.**

**Peron, François** (1755-1810), a French naturalist, wrote the first description of the Tasmanian Aborigines. Peron sailed with the French explorer Nicolas Baudin along the coast of Western Australia and Tasmania. Between 1800 and 1804, he collected more than 100,000 specimens of plants and animals.

**Perón, Juan Domingo** (1895-1974), was president of Argentina from 1946 to 1955, and became president again in 1973. A military revolt ended his first presidency in 1955, and he left Argentina. But he returned in 1973 and was elected president that year. He served as president until his death in 1974.

Perón was born on Oct. 8, 1895, in southern Argentina. He first shared control of the government after a revolution in June 1943. He held three cabinet posts in the government of President Pedro Ramírez. Perón's reform programmes as secretary of labour and social welfare won him the support of labour. He also gained strength from the backing of the army. During World War II, Perón and his associates first favoured Germany and Japan. After Argentina declared war on Germany and Japan in March 1945, Perón was put out of his cabinet office. But he returned and became president of Argentina in 1946. Perón's second wife, Eva Duarte de Perón, helped him rise to power. She died in 1952.

**Juan Perón**

During his first presidency, Perón aimed to make Argentina the leading political, financial, and military power of Latin America. He used press censorship and other violations of civil rights to control his opposition. In 1955, the Roman Catholic Church broke with Perón after he challenged the church's authority. In September 1955, the army and navy revolted and forced Perón to resign. Perón then lived in Spain, but his followers, called *Peronistas,* remained active.

The Peronistas gained strength during the late 1960's and early 1970's, a period of economic problems in Argentina. In 1973, Perón returned to Argentina in triumph and was elected president by a large margin. His third wife, Isabel Martinez de Perón, was elected vice president. Perón died in July 1974, and his wife succeeded him. Isabel Perón was the first woman to become president of a nation in the Western Hemisphere. Argentine military leaders deposed her in March 1976.

See also **Argentina** (Military dictatorships; New political problems; picture); **Perón, Eva Duarte de.**

**Peroxide of hydrogen.** See Hydrogen peroxide.

**Perpetual calendar.** See Calendar.

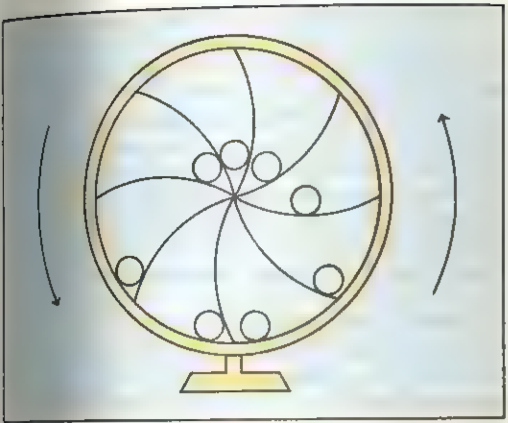
**Perpetual motion machine** is a hypothetical device that can continuously produce work with no energy input, continuously convert energy completely into work, or continuously produce more energy than it consumes. No one has ever succeeded in building a perpetual motion machine, and almost all scientists and engineers believe no one ever will.

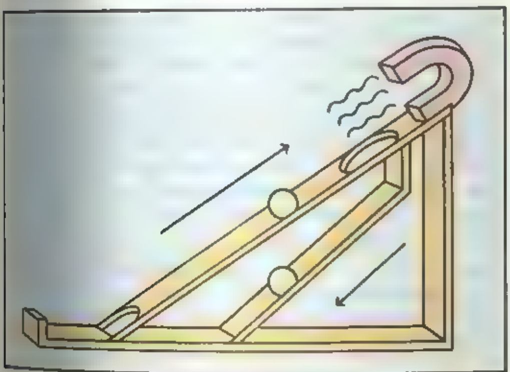
For a machine to achieve perpetual motion, it would have to violate one or both of two *laws of thermodynamics.* These laws summarize how machines work. The first law states that energy cannot be created or destroyed. Energy may change form—for example, from internal energy to mechanical motion—but the total energy of any *system* remains the same. A system may be anything from a simple object to a complex machine. The second law says that heat, by itself, can flow only from a hot object to a colder object. See **Thermodynamics.**

Would-be inventors have proposed at least two kinds of perpetual motion machines. The first kind would run forever with no energy input. The second kind would continuously convert energy completely into work. A machine that would continuously yield more energy than it consumes is considered by some experts to be a third type of perpetual motion machine. Other experts class this device with the first kind of perpetual motion machine.

The first kind of perpetual motion machine violates the first law of thermodynamics. This machine will not work, because resistance opposes the moving parts of all machines. To keep running, the machine must use energy to overcome this resistance. Without energy input, therefore, the machine soon stops.

The second type of perpetual motion machine violates the second law of thermodynamics. This type of machine traditionally does work by exploiting the natural flow of heat from a hot region to a cooler region. But once the flow of heat has warmed the cool region to the same temperature as the hot region, the machine stops. Some inventors have proposed machines that would continuously produce work by completely converting all the energy of the randomly moving molecules in the





**Perpetual motion machines** are supposed to run for ever, but no one has succeeded in inventing such a device. In the overbalanced wheel, *top,* each descending ball is farther from the centre and exerts more force than each ascending ball. But because there are more ascending balls, the wheel does not turn. The magnetic machine, *bottom,* also does not work. Any magnet that can pull a ball up the ramp will not let it go back down.

sea or the atmosphere. But no machine has been able to do this, either.

A machine that would continuously produce more energy than it consumed also violates the first law. This machine would have to create energy.

Some people have considered artificial satellites as possible sources of perpetual motion. But atmospheric friction limits the lifetimes of artificial satellites that orbit relatively close to the earth. Scientists expect that even satellites that orbit the sun may eventually be pulled into it.

Nuclear energy has also been considered by some people to be a possible source of perpetual motion. Uranium and other nuclear fuels do contain tremendous amounts of energy for their size. But after this energy is used up, the remaining matter must be replaced with fresh fuel. See **Nuclear energy.**

See also **Motion.**

**Perrault, Charles** (1628-1703), a French writer, is best known for a book of fairy tales he collected, *Tales of Mother Goose.* The collection, published under his son's name in 1697, includes "Sleeping Beauty," "Little Red Riding Hood," "Bluebeard," "Puss in Boots," "Cinderella," and "Tom Thumb." See **Mother Goose.**

Perrault was born in Paris. He became a high-ranking civil servant and a member of the French Academy under King Louis XIV. His older brother was the famous architect and scientist Claude Perrault. Charles was known for his progressive, evolutionary view of history. He helped start a famous literary battle called "The Quarrel of the Ancients and the Moderns." In *The Century of Louis the Great* (1687) and *Parallels Between the Ancients and the Moderns* (1688), he argued that the culture of his own time was superior to the culture of classical Greece and Rome. He felt that the "Moderns" would win the battle through science, the rational philosophy of René Descartes, and progress in knowledge, culture, and literature.

**Perry** is the family name of two brothers who became famous United States naval officers.

**Oliver Hazard Perry** (1785-1819) became noted for his heroism during the War of 1812, between the United States and Great Britain. At the outbreak of the war, he was a naval lieutenant but had no sea command. Perry offered his services on the Great Lakes, and received command of the Lake Erie naval force.

Except for a brief period when he fought on Lake Ontario and helped capture Fort George in Canada, he spent the spring and summer of 1813 in Erie, Pennsylvania, outfitting his fleet for battle. In August, he left Erie,

**Oliver Hazard Perry** and his fleet of nine ships defeated the British in the Battle of Lake Erie during the War of 1812. The picture on the left shows Perry rowing to the ship *Niagara* after his ship, the *Lawrence,* was disabled.

crossing the Erie bar. The water was so shallow that the guns had to be removed so the ships would not run aground. It is not known why Commander Robert H. Barclay of the British fleet did not attack on this occasion.

Perry made his headquarters at Put-in-Bay, off the Ohio shore, and on Sept. 10, 1813, sailed from there to fight the British. His fleet included nine small ships, the largest of which were the *Lawrence,* commanded by Perry, and the *Niagara,* commanded by Jesse Duncan Elliott. The *Lawrence* flew a motto flag bearing James Lawrence's dying words, "Don't give up the ship." During the battle, the *Niagara* took little part in the fighting. The *Lawrence* suffered many casualties, and finally was disabled. Perry then rowed to the *Niagara.* Under his command, the *Niagara* kept the British from boarding the *Lawrence.* Two British ships became entangled, and the *Niagara* raked them with broadsides. The British fleet of six vessels surrendered after about 15 minutes.

Perry then sent to General William Henry Harrison, the military commander in the West, the famous message, "We have met the enemy, and they are ours." As a reward, Perry was promoted to captain and received a gold medal and a vote of thanks and 7,500 U.S. dollars from the United States Congress. He also was awarded 5,000 U.S. dollars in prize money. The victory gave control of Lake Erie to the Americans. General Harrison was able to cross the lake and take a large part of Upper Canada. Perry helped transport the troops. He later took part in the battle around Detroit and on the Thames River in Canada.

Perry was born in South Kingston, Rhode Island, U.S.A., the son of a naval officer. At the age of 14, he became a midshipman, and served under his father in the West Indies during the naval war with France. During the war with Tripoli, he twice served in the Mediterranean Sea, first, in 1802 and 1803, on board the *Adams,* and again, from 1804 to 1806, on board the *Constellation* and other ships.

In 1807, as a lieutenant, Perry directed the construction of gunboats at Newport, Rhode Island. He next took command of the *Revenge,* which ran aground in a fog in 1811 and was lost. An inquiry cleared Perry of any blame for this loss because a pilot had been in charge of the ship.

Perry commanded the *Java* in the Mediterranean Sea in 1816 and 1817. In 1819, he took a small fleet to Venezuela on a diplomatic mission for the government. While sailing homeward along the Orinoco River after this mission, he contracted yellow fever and died within a few days. He was buried at Port of Spain, Trinidad, but his body was later brought back to Newport, Rhode Island.

**Matthew Calbraith Perry** (1794-1858) opened Japanese ports to world trade. He sailed the first U.S. Navy ships into Tokyo Bay on July 8, 1853. He arranged a treaty with Japan in 1854, protecting American sailors and property in Japanese waters. Naval units sent from other countries to Japan for this same purpose had been fired upon. The Japanese distrusted other countries and had shut themselves off from the rest of the world.

But Perry impressed Japan with a show of force and dignity. He arrived in Tokyo Bay with his decks cleared for action and a letter from President Millard Fillmore. He refused to deal with anyone except the highest officials. Perry's boldness succeeded. He presented his documents to two Japanese princes, who were the emperor's representatives. Perry then went to China to give the Japanese time to study Fillmore's proposals. He returned to Japan in February 1854, and again made a show of force in Tokyo Bay. A few weeks later the Japanese signed a treaty in Yokohama, granting the United States trading rights in two Japanese ports, Hakodate and Shimoda. Perry returned to Washington as a member of the naval efficiency board. He published his record of the expedition, *Narrative of the Expedition of an American Squadron to the China Seas and Japan,* in 1856.

The opening of Japan was one of history's most significant diplomatic achievements. It changed American and European policy toward Japan and brought about a change inside Japan. Within 50 years, Japan had become a great world power (see **Japan** [History]).

**Commodore Matthew Perry** landed in Yokohama and met with the commissioners of the emperor. By his stern manner and firm display of arms, he forced Japan to open its ports to world trade.

Perry was born in Newport, Rhode Island, U.S.A. At the age of 15, he enlisted as a midshipman on the *Revenge*, commanded by his brother, Oliver Hazard Perry. From 1810 to 1812, he served on the *President*. As a lieutenant, he was an executive officer of the *Cyane*, which helped found a colony of black Americans in Africa in 1820.

Perry's first independent command was the *Concord*, in which he took John Randolph to Russia as the United States envoy in 1830. During the next 10 years, Perry was active in naval affairs and originated the apprentice system for the education of seamen. Perry became a captain in 1837, and later took command of the *Fulton II*, one of the first naval steamships. In 1839 and 1840, he directed the first school of naval gunnery, on board the *Fulton II*. In 1843, he commanded the African Squadron which aided in wiping out the slave trade, and helped protect settlements of American blacks in Africa.

In the Mexican War, Perry commanded the *Mississippi* and served as commander in chief of the squadron off the east coast of Mexico. His squadron, up to that time the largest under the U.S. flag, worked with army forces led by General Winfield Scott in the siege and capture of Veracruz. From 1848 to 1852, Perry served at the New York Navy Yard directing the building of mail steamships. In 1852, he again took command of the *Mississippi* to protect American fisheries off the coast of British provinces in America.

**Perry, Fred** (1909-1995), was one of the United Kingdom's most outstanding tennis players. He played in the British winning Davis Cup team from 1933 to 1936. In 1934, 1935, and 1936 he was Wimbledon singles champion. He won five other international championships between 1933 and 1936. He became a professional after 1936.

Frederick John Perry was born at Stockport, England. He became an American citizen in 1940.

**Perse, Saint-John** (1887-1975), was the pen name of Alexis Léger, a French poet and diplomat. He received the Nobel Prize for literature in 1960.

Perse was born in the West Indies. Until World War II, he led a dual existence. Under his real name, he became secretary-general of the French ministry of foreign affairs. Under his pen name, he published the epic poem *Anabase* (*Anabasis*, 1924). After German forces occupied France in 1940, Perse went into exile in the United States. It was not until this time that the true identity of "Saint-John Perse" became known.

Perse remained in Washington, D.C., until 1959, and he wrote most of his poetry there—*Exil (Exile)*, *Vents (Winds)*, *Amers (Seamarks)*, and *Chronique*. This poetry sings of human experience, using a rich ceremonial style. Through the interplay of abundant and varied images, Perse tries to convey the immediate presence of "man in the fullness of his being."

**Persephone** was a beautiful goddess in Greek and Roman mythology. The Greeks also called her *Kore*. The Romans called her *Proserpina*. Persephone was the daughter of Demeter (Ceres in Roman mythology), the goddess of agriculture and fertility. Persephone's father was Zeus (Jupiter), the king of the gods. A myth describes Demeter's search for Persephone after the girl was kidnapped by Hades (Pluto), god of the dead.

One day, while Persephone was picking flowers in a meadow, the earth opened up. Hades seized her and carried her to his underworld kingdom to become his wife. Demeter was heartbroken at the loss of her daughter and wandered all over the world looking for her.

Demeter became angry with the gods for allowing Persephone to be carried off. In revenge, Demeter refused to let crops grow. To return fertility to the earth, Zeus ordered Hades to return Persephone to her mother. But while in the underworld, Persephone had eaten seeds of the pomegranate, a fruit that symbolized marriage. By eating the seeds, she entered into a marriage with Hades that could not be ended.

Zeus arranged a compromise between Demeter and Hades. Persephone would spend two-thirds of each year with her mother and the remaining third with Hades. During the summer, while Persephone lived with Hades, the earth became dry and barren, reflecting Demeter's unhappiness. But during the winter, while Demeter and Persephone lived together, crops flourished. In Greece, farmers grow crops during the country's mild, moist winters. The myth of Persephone was used to help explain the cycle of fertility in nature.

See also **Adonis; Demeter.**

**Persepolis** was a capital of ancient Persia. King Darius I of Persia founded Persepolis in about 518 B.C. in a mountainous region of what is now southwest Iran. Darius and his successors built large stone and mud-brick palaces in the capital, which became the royal ceremonial centre for the religious holiday of the New Year. Every year at this festival, the king would renew his divine right as king, and representatives of all the peoples within the Persian Empire would bring him gifts. In 330 B.C., Alexander the Great seized Persepolis.

Archaeologists have uncovered many of the ruins of Persepolis. Some ruins have been restored. Visitors may see a representation of the procession of New Year's gift givers carved in stone on two grand staircases leading to the king's Audience Hall (see **Sculpture** [picture: Lion fighting a bull]).

See also **Persia, Ancient** (pictures).

**Perseus** is a constellation of the northern sky. It lies between the constellations of Auriga and Cassiopeia. Mirfak, the brightest star in Perseus, is larger than the sun. Perseus contains the *binary star* Algol. The pair of stars called Algol periodically eclipse one another, so that Algol appears alternately fainter and brighter (see **Algol**). In Greek mythology, Perseus won this place among the stars for cutting off the head of the monster Medusa. See also **Constellation; Star** (picture: An exploding star).

**Perseus,** in Greek mythology, was the son of the god Zeus and the mortal Danaë. King Acrisius, Danaë's father, learned from an oracle that his own grandson would someday kill him. In fear, he set the infant Perseus and Danaë adrift in a chest. Dictys, a fisherman, rescued them. Perseus grew to manhood in Dictys's home on the island of Seriphus.

King Polydectes, Dictys's brother, tried to force Danaë to marry him. To prevent the marriage, Perseus agreed to slay Medusa, a snake-haired monster called a Gorgon whose horrible face turned all who looked at her to stone. With the help of the goddess Athena, Perseus beheaded Medusa while gazing at her reflection in his shield (see **Gorgons; Medusa**).

**Ruins of Persepolis,** ancient Persia's greatest city, lie in southwestern Iran. Darius I built the centre in about 518 B.C. Parts of Darius' audience hall, *above,* and palace are still standing.

While returning home, Perseus rescued the beautiful maiden Andromeda from a giant sea monster and married her. In Seriphus, he turned Polydectes to stone with the head of the Medusa. Perseus later accidentally killed his grandfather with a discus, fulfilling the prediction of the oracle.

**Pershing, John Joseph** (1860-1948), commanded the American Expeditionary Forces (A.E.F.) in Europe during World War I. The A.E.F. was the first United States Army ever sent to Europe. The Allied generals wanted to use the American troops to fill the ranks of their battered armies, but Pershing insisted that, except in certain cases, the American Army should fight independently. He believed that the knowledge of a large, fresh American Army would hurt German morale. Also, the Americans had been trained for fast, driving warfare, which Pershing believed was needed to win. Pershing opposed the slow trench warfare of the Allied armies. Pershing's army grew within 18 months from a small group of regulars to almost 2 million men. After the war, he received the highest rank that had ever been given an American Army officer, General of the Armies of the United States. However, the same title was granted to George Washington in 1976, confirming him as the senior general officer on the U.S. Army rolls. See also **World War I** (The United States enters the war).

**Persia.** See **Iran; Persia, Ancient.**

**Persia, Ancient,** was a land that included parts of what are now Iran and Afghanistan. Under Cyrus the Great, Darius I, Xerxes, and other leaders, it became the home of a great civilization and the centre of a vast empire. The name *Persia* came from *Persis,* which was the Greek name for the region. The Persians themselves called the region the *land of the Aryans,* from which the name *Iran* comes. The Persians called their language *Aryan.*

The early Persians were nomads who came to the area from what is now the southern Soviet Union in about 900 B.C. They were good organizers and administrators, and the empire they created lasted over 200 years. They made important contributions in government, law, and religion. The Persians developed an efficient system of postal delivery using relays of fast horses. They also built an irrigation system, and tried to standardize weights and measures. For a quotation about their postal system, see **Post office** (Ancient times).

The Persians treated their subjects better than earlier rulers had, and they probably influenced the actions and policies of later governments. Alexander the Great built on Persian accomplishments to unify his empire. So did the Arabs in building their civilization.

In the 500's B.C., Persia became the centre of the vast Achaemenid Empire, which included most of the known

world. It extended from North Africa and southeastern Europe in the west to India in the east, and from the Gulf of Oman in the south to the Caucasus Mountains and the Syr Darya River in the north. Persians invaded Greece in the early 400's B.C. But the Greeks drove them from Europe, ending the empire's expansion. Alexander the Great conquered the empire in 331 B.C. Later, Parthians and Sassanids controlled Persia before it was conquered by Arabs in A.D. 641.

### Way of life

**The people.** Ancient sculptures show that the Persians were a handsome people with long, straight noses. Persians dressed in long robes, later called *caftans,* and wore jewellery and false hair.

Most of the common people lived in mud huts, very much like the huts in which many of the country people of Iran live today. Nobles and kings built large stone houses and palaces. The ruins of some of these buildings are still standing today.

The Persians adopted many of the customs of the Elamites, the people they had conquered. But they kept many traditions of the *nomadic* (wandering) peoples. For example, they taught their sons to ride horses, shoot bows, and speak the truth. The Persians considered it a disgrace to lie or to be in debt.

Early Persian families formed into clans, and clans into tribes. But as the empire grew, social units larger than the family began to disappear. Persian men could have several wives. A king could select his wives only from the six highest families. Rulers had large *harems,* where all the women in the family lived.

**Language and literature.** The people of ancient Persia spoke Old Persian, a language of the Indo-European family related to the Sanskrit language of India and to modern Persian. The Persians developed a cuneiform system of writing (see **Cuneiform**). But the cuneiform system was used only for royal inscriptions, because few people could read it. The Persians used Aramaic, a Semitic language related to Hebrew, as a written language. Aramaic was widely used in Syria, Palestine, and Mesopotamia then, and the Persians extended its use to India, central Asia, and Asia Minor (now Turkey). Local languages were used in various parts of the empire.

Little is known of the literature of ancient Persia. But stories of ancient heroes still survive, probably passed down by minstrels and through folk tales.

**Religion.** The Persians believed in gods of nature, such as the sun and sky. The people believed the gods had social powers. Mithra, the god of light, for example, controlled contracts. The Persians had no temples. They prayed and offered sacrifices on mountains.

Zoroaster (or Zarathustra), a prophet who lived sometime between 1400 and 1000 B.C., reformed the ancient religion. He preached a faith based on good thoughts, words, and deeds, emphasizing a supreme god called Ahura Mazda, "the wise spirit." Zoroaster's followers, called *Zoroastrians,* gradually spread his religion all over Persia. Zoroaster's teachings are found in the *Gathas,* part of a holy book called the *Avesta.*

**Art and architecture** in ancient Persia was a unique mixture of Greek, Egyptian, Babylonian, and other cultures. Remains of huge royal palaces that stood at Pasargadae, Persepolis, and Susa have been found in what

**A bronze Persian head** was cast in the 1000's B.C.

**Silver drinking cup** was used by a king or nobleman.

**Persian coins.** The Achaemenid coin, *left,* was minted in the 400's B.C. The Sassanian coin, *right,* dates from about A.D. 400.

**The winged Ahura Mazda,** shown in an image below, was the chief god of ancient Persia and symbol of Zoroastrianism.

is now Iran. Goblets, plates, and other objects made of gold during the Persian Empire have been found. After Alexander the Great conquered Persia, silver became popular, and many silver art objects have been found. Many museums exhibit ancient Persian textiles, rugs, and pottery.

**Economy.** Early Persians were farmers. They raised grain and livestock. Deserts covered much of the highland region, and the peasants developed irrigation to grow wheat, barley, oats, and vegetables. They used underground tunnels to avoid evaporation by the hot sun, and brought water as much as 160 kilometres from the mountains to the valleys and plains. Highland Persia had few large towns until Alexander the Great conquered it. Crafts developed after cities were founded. Pottery, weaving, and metal work in copper, iron, gold, and silver became important occupations. Pots and pans became more important than weapons, armour, and farming tools. Potters and weavers made clothing, pottery, and rugs for the people.

Caravans carried trade goods from many parts of the world through Persia to the Mediterranean Sea. Important articles of trade included precious and semiprecious stones, and spices. A silk route to central Asia and China was opened, probably during the 100's B.C. Trade routes from Mesopotamia to the Far East led across Persia, skirting the central desert.

Other routes led east to India, and north to the Caucasus Mountains and the Black Sea. The Persians built roads between the important cities in their empire. The most famous was the royal road that linked Sardis in western Asia Minor to Susa near the Persian Gulf. The Persians used the roads to deliver post swiftly by relays of horsemen.

## Government

Well-organized bureaus governed the Achaemenid Empire (about 550-331 B.C.). The empire was divided into provinces called *satrapies,* each satrapy governed by an official called a *satrap.* Satraps ruled and lived like minor kings. But the *king of kings,* who ruled the empire from Persia, had final and absolute authority. The kings *codified* (systematized) the laws in various parts of the empire. Troops in the satrapies were controlled by the central government. A secret service, which the Greeks called the "eyes and ears of the king," informed the king of affairs throughout the empire.

Under the Parthians (155 B.C.-A.D. 225) and Sassanids (A.D. 224-641), Persians kept the title king of kings. Some of these Persian rulers were strong, but others were weak. Local lords exercised great powers during the Parthian period. A powerful state church existed under the Sassanids. Priests served in important civil posts, but church and state remained separate.

## History

**Early civilization.** The first known civilization in Persia was that of the Elamites, who settled the region perhaps as early as 3000 B.C. Tribes of Medes and Persians wandered into Persia beginning about 900 B.C. The Medes created the first state on the Persian plateau about in 700 B.C., and reached the height of their power

**Persian Empire about 500 B.C.**

This map shows the Achaemenid Empire at its peak in about 500 B.C., during the reign of Darius I. Persis, later called *Persia,* was the centre of an empire that stretched west to the central Mediterranean Sea, east to northeastern India (now Pakistan), and from the Gulf of Oman in the south to the southern part of the present-day Soviet Union in the north. Darius ruled from several capitals.

**An Achaemenid cylinder seal** shows King Darius killing a lion. Impressions were made by rolling the seal across soft clay.

in the late 600's B.C. The Persians, led by Cyrus the Great, overthrew the Medes in about 550 B.C.

**The Achaemenid Empire.** Cyrus enlarged the Median empire by seizing the kingdom of Lydia around 545 B.C. and gradually absorbing Greek colonies in Ionia, in western Asia Minor. He called this the Achaemenid Empire, after his ancestor, Achaemenes. He conquered Babylonia in 539 B.C. and freed the Jews in captivity there. They returned to Palestine. Cyrus was killed in 530 B.C. He had created an empire that extended from the Mediterranean Sea and western Asia Minor to the upper Indus River in what is now northern Pakistan, and from the Gulf of Oman to the Aral Sea.

Cambyses, Cyrus' son, conquered Egypt in 525 B.C., but died on his way back to Persia. A civil war for control of the empire followed, and Darius I, a relative of Cambyses, became king in 522 B.C.

Darius reorganized the government under the satrapy system, established the absolute power of the king of kings, and developed a regulated system of taxation. He also built palaces at Persepolis and Susa, two of his capitals. He expanded the Persian Empire into southeastern Europe and into what is now southern Pakistan.

About 513 B.C., the Persian army invaded the area west and north of the Black Sea, but did not conquer much land. Darius sent an army into Greece in 490 B.C., but it was defeated by Athenian forces at Marathon. Darius died in 486 B.C., while preparing for new attacks on Greece.

Xerxes, Darius' son, invaded Greece in 480 B.C., and defeated a force of Spartans and other Greeks after a fierce battle at Thermopylae. But the Persians suffered crushing defeats at Salamis and Plataea, and were driven from Europe in 479 B.C. See **Greece, Ancient** (The Persian Wars).

After Xerxes' death, Persia declined. But the empire continued to exist in spite of revolts until 331 B.C., when Alexander the Great defeated a huge Persian army at the Battle of Arbela (sometimes called the Battle of Gaugamela). This ended the Achaemenid Empire, and Persia became part of Alexander's empire.

**The Seleucid dynasty.** More than 10 years after Alexander's death in 323 B.C., one of his generals, Seleucus, started a dynasty that ruled Persia and nearby areas. The Seleucids founded many cities and introduced Greek culture into western and central Asia. From 155 B.C., the Parthians won control of Persia.

**The Parthian Empire** lasted until A.D. 224. The Parthians built a large empire across eastern Asia Minor and southwest Asia. During the last 200 years of their rule, the Parthians had to fight the Romans in the west and the Kushans in what is now Afghanistan. Civil wars erupted in the Parthian Empire.

In about A.D. 224, a Persian named Ardashir overthrew the Parthians and seized the Parthian Empire. After more than 550 years under other rulers, Persians again ruled Persia.

**The Sassanid dynasty,** named in honour of Sassan, grandfather of Ardashir, ruled Persia until the mid-600's. Wars between Persians and Romans continued through much of the Sassanian reign. After the Romans adopted Christianity in the 300's, the conflict seemed to become a religious struggle between Christianity and Zoroastrianism, the religion of the Persians.

The Sassanian civilization reached its high point in the mid-500's. Persians won several victories over the Romans, and reconquered land that had been part of the Achaemenid Empire. Persian troops advanced to the walls of Constantinople (now Istanbul, Turkey), then the capital of the Byzantine (East Roman) Empire. But they were defeated there and forced to withdraw from all the land they had conquered.

The rise of Islam, a new religion in Arabia, brought a sudden end to the Sassanid dynasty in the mid-600's. Arabs invaded Persia and defeated the Persians in 637 and during the 640's. Islam spread across the Persian plateau. But the new Islamic rulers kept much of Persia's organization, art and architecture, and culture.

For the history of Persia after the Arab conquest, see **Iran** (History).

**Investiture of Ardashir I,** a rock relief sculpture at Naqshi-Rustam, near Persepolis, shows Ardashir, *left,* founder of the Sassanid dynasty, taking the symbol of royalty from Ahura Mazda, the supreme Zoroastrian god.

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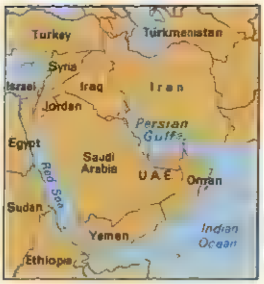
**Persian Gulf**






**Persian Gulf** is a kidney-shaped body of water in southwestern Asia between Iran and the Arabian Peninsula. Arabs call it the *Arabian Gulf.* The Strait of Hormuz links the gulf to the Gulf of Oman, an arm of the Indian Ocean. The Persian Gulf is about 800 kilometres long and averages about 200 kilometres in width. It covers about 260,000 square kilometres and is about 90 metres deep at the deepest point. Such sea animals as oysters and prawns thrive in the gulf.

The gulf is bordered by Iran, Iraq, Kuwait, Saudi Arabia, Bahrain, Qatar, the United Arab Emirates, and Oman. The gulf region has more than half the world's proven reserves of petroleum and natural gas. Oil and gas from the region power much of the world's industry and earn the gulf states a great deal of money each year.

In ancient times, most towns along the Persian Gulf were self-governing city-states that thrived as ports. During the 1800's, Great Britain gained influence over much of the region. Some of the gulf states gained independence during the early 1900's. By 1971, all of the gulf states were independent, and Britain left the area completely. The Persian Gulf was the centre of a damaging war between Iran and Iraq (1980-1988) and of the Persian Gulf War of 1991 (see **Persian Gulf War**).

**Persian Gulf War** was fought in early 1991 between Iraq and a coalition of 39 countries organized mainly by the United States and the United Nations (UN). The war took place chiefly in Iraq and the tiny oil-rich nation of Kuwait, which Iraq had invaded and occupied. These two countries lie together at the northern end of the Persian Gulf. Leading nations in the coalition that defeated Iraq included Egypt, France, Saudi Arabia, Syria, the United Kingdom, and the United States.

Iraq's invasion of Kuwait on Aug. 2, 1990, followed failure to settle disputes between the two states. Iraq's action appeared to threaten neighbouring Saudi Arabia, and the coalition of countries against Iraq was formed to combat this threat. War became inevitable after Iraq ignored demands for it to leave Kuwait. The final United Nations deadline for withdrawal was Jan. 15, 1991. Two days later, the war began.

The Persian Gulf War was won by the coalition in the air. Coalition combat aircraft completely destroyed Iraq's air power and many of its military and industrial facilities. After five weeks of continuous air bombardment, the coalition launched a ground attack into Kuwait and southern Iraq. It met little resistance, and after 100 hours Iraq surrendered.

**Causes of the war.** Saddam Hussein had been president of Iraq since 1979. He was ambitious for power and leadership in both the Middle East and the Organization of Petroleum-Exporting Countries (OPEC). Along with such countries as Kuwait and Saudi Arabia, Iraq was a major oil-exporting member of OPEC. But from 1980 to 1988, Iraq had fought a bitter war with its neighbour Iran.

Iraq had suffered serious economic damage as a result of the Iran-Iraq War. It had run up debts with Kuwait and other countries as a result of fighting the war. However, Iraq emerged from the conflict as the second-strongest military power in the Middle East. Only the Jewish state of Israel, whose existence was opposed by the Arab nations, was stronger.

Hussein argued that Iraq had become the chief Arab power opposed to Israel and should thus be recognized as leader of the Arab world. As leader of the Arab world, Iraq should receive help from other Arab countries in rebuilding its economy. OPEC should help Iraq by raising world oil prices and cancelling Iraqi debts to Kuwait and other Arab countries.

*Dispute between Iraq and Kuwait.* After the Iran-Iraq War, Hussein had disagreed with Kuwait's leaders over how much debt cancellation and other financial aid Kuwait should provide for Iraq's economic recovery. Iraq also accused Kuwait of lowering world oil prices by producing more oil than was allowed by OPEC, and of taking Iraqi oil from the Rumalla oil field, a petroleum deposit lying beneath both Kuwait and Iraq.

In addition, Iraq had often claimed that Kuwait should be part of Iraq. In the 1800's and early 1900's, Kuwait had been part of a province of the Ottoman Empire called Basra. But by the time Iraq was formed in the early 1920's, Kuwait was no longer part of the province. Both Kuwait and Iraq came under British control. Iraq became independent in 1932 and Kuwait did so in 1961. Iraq did not recognize Kuwait's independence until 1963. After 1963, disputes continued between Iraq and Kuwait over the location of their common border.



**Allied forces attacked** from the air, sea, and land during the Persian Gulf War. In January 1991, allied aircraft, including the French warplane above, began bombing military targets in Iraq and Kuwait, while U.S. ships in the Persian Gulf launched cruise missiles, *top right.* In February, allied ground forces, including Saudi tanks, *bottom right,* quickly defeated Iraq.

*Iraqi aims.* By seizing Kuwait, Hussein hoped to capture that country's oil wealth for Iraq, raise Iraq's status in OPEC, and wipe out a large part of Iraq's debts. Hussein also sought better access to the Persian Gulf. Iraq's coastline was short, but that of Kuwait was long, and included an excellent harbour.

**Iraq's invasion of Kuwait.** At 2 a.m. local time on Aug. 2, 1990, hundreds of Iraqi tanks and other forces crossed the Kuwait border. Within 24 hours, Iraq had complete control of Kuwait. Thousands of Iraqi troops then moved to Kuwait's border with Saudi Arabia. Some people thought Iraq might invade Saudi Arabia also. On August 8, Iraq announced it had annexed Kuwait.

Many countries within the UN attacked Iraq's invasion. However, Hussein claimed that if these countries condemned Iraq's action, they should also condemn Israel's continued occupation of lands it had won from Arab nations during the Arab-Israeli wars. Some Arabs, especially poor Arabs of Palestinian origin, supported Iraq's invasion of Kuwait. They acclaimed Hussein a hero for standing up to Israel and the United States, Israel's ally. Hussein won further support from them by demanding that the vast wealth of the major oil-exporting Arab nations be shared equally among all Arabs.

In New York, the UN Security Council passed a resolution condemning the invasion as soon as it had happened. On August 6, the Security Council imposed *sanctions* on Iraq. These were measures authorizing a prohibition on all trade with Iraq, except for medical supplies and food in certain circumstances. In the same month, the United States set about sending troops to the Persian Gulf to protect Saudi Arabia. The United States became head of a coalition of nations against Iraq that eventually consisted of 9 Arab states, including Kuwait, and 30 non-Arab countries.

Iraq's occupation of Kuwait was harsh. It brought considerable hardship to Kuwaiti citizens. Iraqi troops killed or imprisoned Kuwaiti civilians, carried out widespread looting, and, according to some accounts, seized essential supplies such as drugs and hospital equipment for shipment back to Iraq. From mid-August, Iraqi authorities began detaining foreign nationals in both Iraq and Kuwait. Many of these foreign hostages were moved to military or industrial sites. Hussein hoped that, if war came, the hostages would be a "human shield" against coalition attacks. By mid-December, however, Iraq had released all its hostages under pressure from other countries, including certain Arab states.

On November 29, the UN Security Council passed a resolution authorizing coalition members to "use all necessary means" to expel Iraqi troops from Kuwait if Iraq failed to withdraw them itself by Jan. 15, 1991. Iraq chose to stay in Kuwait.

**Opposing forces.** By mid-January 1991, coalition forces in the Persian Gulf totalled about 670,000 troops, 3,500 tanks, and 1,800 combat aircraft. Some 425,000 of the troops came from the United States, with the rest drawn from another 27 of the coalition members. Most came from France and the United Kingdom, and certain Arab countries, including Egypt, Saudi Arabia, and Syria. Coalition countries that did not send troops provided supplies or money instead. Coalition naval support consisted of about 200 ships, including 6 U.S. aircraft carriers and 2 U.S. battleships. Iraq had about 500,000 troops

in Kuwait and southern Iraq, and had about 4,500 tanks, 550 combat aircraft, and a small navy.

**The war.** At 3 a.m. on January 17, coalition forces began bombing industrial and military targets in Iraq and later also in Kuwait. This was the start of an air war that lasted more than five weeks. During this first phase of the Persian Gulf War, the coalition sought to destroy Iraq's ability to launch attacks. Other objectives were eliminating Iraq's biological, chemical, and nuclear weapons facilities; establishing superiority over Iraq's air force; destroying Iraq's information-gathering capabilities; and reducing the battle-readiness of Iraqi soldiers in Kuwait and southern Iraq. Night-sight devices, precision-guided weapons (some launched from ships in the Gulf), and other high-technology equipment helped the coalition achieve many of its aims. In time the coalition concentrated its heavy bombing on food stores, fuel and ammunition dumps, and supply routes.

In retaliation, Iraq launched missile attacks on populated areas in Saudi Arabia and in Israel. Its "scud" missiles caused some deaths and injuries and much property damage in the places where they fell. By attacking Israel, Hussein hoped to draw it into the conflict and disrupt Arab support within the coalition. But Israel stayed out of the war, so his plan failed.

Hussein also ordered the destruction of Kuwait's oil-wells. More than half of the state's 1,300 wells were set on fire, pouring thick smoke and gases into the atmosphere. Iraqi troops also allowed 1.75 billion litres of oil to pour into the waters of the Persian Gulf. The resulting oil slick threatened to contaminate Saudi Arabia's *desalination facilities,* which remove the salt from sea water to provide drinking water and water for irrigation. It polluted coastal areas and did immense long-term harm to the wildlife of the Gulf.

The only ground battle during the first phase of the war was at the Saudi town of Khafji, near the Kuwaiti border. On January 29, Iraqi troops occupied Khafji, which the Saudis had earlier deserted. On January 31, Saudi and Qatari forces recaptured it with U.S. help.

Phase two of the war began on February 24, when coalition forces launched a major ground attack into Iraq and Kuwait. Coalition troops pushed into western Iraq and southern Kuwait. They encountered little resistance from the Iraqi army. With their supply lines cut, Iraqi troops in Kuwait had little choice but to surrender. On February 26, Saddam Hussein ordered the withdrawal of his forces from Kuwait. The coalition forces ended all military operations against Iraq on February 28.

**The end of the war.** Iraq accepted a formal cease-fire on April 6. On April 11, the UN Security Council officially declared the war over. Under the cease-fire agreement, Iraq promised to pay Kuwait war damages and agreed to the destruction of its biological and chemical weapons, its facilities for making such weapons, and any facilities it might have for making nuclear weapons. UN inspectors were later assigned to supervise the destruction. The UN continued sanctions against Iraq to ensure it kept to the agreement. However, Iraq resisted complying with the terms of the cease-fire agreement.

**Aftermath.** As many as 100,000 Iraqi troops may have died in the war, but some experts believe the total is much lower. Deaths among coalition troops totalled about 370. Coalition bombing damaged Iraq's transportation and communications systems and major industries. Iraq's already shaky economy was shattered. Water and electricity supplies were disrupted or destroyed, which led to civilian deaths in the postwar period. The end of the war triggered rebellions against Saddam Hussein by Kurds in northern Iraq and by Shiite Arabs in the south. Hussein used his army to suppress these revolts ruthlessly. Many Shiites fled into Iran, and Kurds took refuge in the mountains bordering northern Iraq and Turkey. Many of them died of disease, exposure, or hunger. Between April and July 1991, U.S. and other coalition troops established safety zones and refugee camps in northern Iraq to protect the Kurds. In August 1992, the U.S. and its allies established an air exclusion zone in the south to protect Shiite Arabs.

In January 1993, the United States, the United Kingdom, and France launched air strikes against targets in southern Iraq to force Iraq to comply strictly to the UN resolutions and the cease-fire agreement. More fighting took place in November 1993 on the Kuwaiti border. The Iraqis were protesting against a Kuwaiti security trench.

**Persian lamb.** See Karakul.

**Persian lynx.** See Caracal.

**Persian wars.** See Greece, Ancient (History [The Persian wars]).

**Persimmon** is the name of more than 200 species of small trees that belong to the ebony family. Two species are grown for their pulpy, edible fruits, also called *persimmons.* They are the *kaki* or *Japanese persimmon* and the *common persimmon.* The kaki is native to central and northern China. It is grown commercially in China, Japan, the Mediterranean region, and the Southern United States. It has large, shiny, dark-green leaves and yellowish-green flowers. The common persimmon is native to the Southeastern United States.

Persimmon fruits are round or egg-shaped and range from 1 to 5 centimetres in diameter. They usually are yellowish or orange, but may be streaked with red. They contain a strong astringent that causes a person's mouth to pucker. A persimmon tastes best when it is so ripe that it looks wrinkled and almost spoiled. Then it has a sweet, fruity flavour. American Indians made a kind of

**Persimmons** are pulpy, edible fruit. The *kaki* or *Japanese persimmon, above,* has large, shiny, dark-green leaves.

bread by mixing persimmon pulp with crushed maize. Persimmon pudding is a common delicacy in the Southeastern United States.

**Scientific classification.** Persimmons belong to the ebony family, Ebenaceae. The Japanese persimmon is *Diospyros kaki.* The North American persimmon is *D. virginiana.*

**Persistent vegetative state.** See **Death** (Defining death).

**Person,** in grammar, is the feature of a language that shows the difference between the speaker, the person spoken to, and a person or thing spoken about. If a word stands for the speaker, it is in the *first person.* If it stands for the person spoken to, it is in the *second person.* If it stands for any other person or thing, it is in the *third person.* English shows person by a change in the form or spelling of a personal pronoun or verb. Nouns do not have different forms to show person.

Different forms of personal pronouns show person. *I* and *we* are first person. *You* is second person. *He, she, it,* and *they* are third person.

Verbs change form to show person only in the third person, singular, present tense. An *-s* or *-es* is added to the first (or second) person, singular, present tense, to form the third person. I *drive* is first person, you *drive* is second person, but he *drives* is third person.

The word *be* changes form to show person in the singular, present tense as follows: I *am,* you *are,* he *is.* But plural forms of *be* in the present tense are the same: we *are,* you *are,* they *are.* First and third person forms of *be* in the singular, past tense, are alike, but the second person is different: I *was,* he *was,* but you *were.*

See also **Pronoun; Verb.**

**Personal computer.** See **Computer.**

**Personal liberty.** See **Habeas corpus; Government** (Individual rights).

**Personal name.** See **Name.**

**Personality** is a term that has many general meanings. Sometimes the word refers to the ability to get along well socially. For example, we speak of experiences or relationships which are said to give a person "more personality." The term also may refer to the most striking impression that an individual makes on other people. We may say, "She has a shy personality."

To a psychologist, personality is an area of study that deals with complex human behaviour, including emotions, actions, and *cognitive* (thought) processes. Psychologists study the patterns of behaviour that make individuals different from one another.

## The nature of personality

**Personality types.** For hundreds of years, people have tried to group the vast differences among human beings into simple units. Some of the resulting groupings divide people into personality types based on certain characteristics.

The ancient Greek doctor Hippocrates divided individuals into such types as *sanguine* (cheerful) and *melancholic* (depressed). He attributed their behavioural differences to a predominance of one of the body fluids. For example, Hippocrates believed that a person was cheerful if blood (sanguis) was the dominant influence on his or her behaviour.

Some of the more recent theories about personality types have tried to associate body build and temperament. Classifications based on body measurements were developed by two psychiatrists, Ernst Kretschmer of Germany and William Sheldon of the United States.

The Swiss psychologist Carl Jung, who studied psychological characteristics, classified people as introverts or extroverts (see **Extrovert; Introvert**).

The simplicity of personality-type theories is appealing, but it also limits their value. An individual's behaviour is so complex, diverse, and variable that the person cannot be sorted usefully into a simple category.

**Personality traits.** Related to personality-type theories is the search for broad traits or dispositions to describe enduring differences among people. One of the early workers in this field was the British psychologist William McDougall. Personality traits are regarded as dimensions that range from high to low. For example, anxiety is a trait that varies from the greatest anxiety to the least anxiety. Most people have some degree of anxiety along the scale between the two extremes. Psychologists have studied such personal attributes as aggressiveness, dependency, and extroversion-introversion.

Studies of personality traits help reveal the relationships between an individual's different personal attributes. For example, a group of children may be tested for intelligence and may also be given questionnaires about their attitudes. In addition, they may be asked to rate their own characteristics, and may be rated by their teachers. The results are then correlated statistically to discover the relationships among all this information.

**Ratings and self-reports.** Research on personality traits tends to rely heavily on broad ratings of personality. In self-ratings, a person indicates the degree to which he or she thinks he or she possesses certain personality characteristics. Ratings may also be obtained from teachers, or others who know the person or who have watched the person in special situations.

These judgments may be affected by many types of bias. A person may give the responses that he or she thinks are expected and socially desirable, even if they are not true. Moreover, the answers may reflect preconceptions and *stereotypes* (fixed ways of thinking), rather than an accurate description of behaviour. Tests that ask a person to rate such attributes as friendliness or adjustment provide broad self-characterizations rather than detailed descriptions of behaviour. Consequently, the findings of such tests may partly reveal the concepts and stereotypes that people apply to themselves and to others. These findings may not necessarily reflect the people's actual behaviour outside the test.

Some techniques are designed to reduce the role of personal meanings and concepts. Other approaches deliberately seek to clarify the individual's concepts about himself or herself. These personal concepts are especially important in theories that stress the role of the self and one's image of oneself. For example, in his theory of self-realization, the American psychologist Carl R. Rogers focuses on *phenomenology*—a person's private experiences and perceptions.

**Projective tests.** Some investigators have tried to avoid the problems of relying on a person's ratings or reports about himself or herself by creating indirect clinical techniques in the form of projective tests. These methods require the person to respond to a situation in which there are no clear guidelines and no right or

wrong answers. The person may be asked how inkblots appear to him or her on the Rorschach Test. Or the person may be instructed to create a story about the characters in a series of pictures in the Thematic Apperception Test. Projective techniques rely on a trained clinician to interpret the person's attributes indirectly from test behaviour. The value of this approach for revealing aspects of personality is controversial and is still being studied.

**Freud's psychoanalytic theory.** According to the Austrian physician Sigmund Freud, the personality has three parts: (1) the *id,* which represents instinctive impulses of sex and aggression; (2) the *ego,* which represents the demands of the real world; and (3) the *superego,* or conscience, which represents standards of behaviour incorporated into the personality during childhood.

According to Freud, mental life is characterized by internal conflicts that are largely unconscious. Impulses from the id seek immediate gratification, but they conflict with the ego and the superego. When unacceptable impulses threaten to emerge, a person experiences anxiety. To reduce this anxiety, the person may use various personality defences. The person may, for example, *displace* (transfer) his or her emotions to less threatening objects. A child who is afraid to express aggression toward his or her father may become angry at his or her pet dog instead.

Freud's ideas have had great influence on the study of personality, but they are highly controversial. Many of his ideas had to be modified severely by psychologists to take greater account of social and environmental variables. See **Developmental psychology.**

### Personality and environment

Trait theories and psychoanalytic theories both assume that broad internal personality dispositions determine behaviour in many situations. However, research on the consistency of various personality traits indicates that what people do, think, and feel may depend greatly on the specific conditions in which their behaviour occurs.

People may be honest in one situation and dishonest in another. They may be passive in some situations but aggressive in other situations or with different people. Many contemporary approaches to the study of personality therefore emphasize the role of specific social experiences and environmental events in the development and modification of behaviour. Psychologists are gradually moving away from broad theorizing about the nature of personality. Instead, they are studying the conditions that determine complex behaviour.

**Personality development.** Some psychologists have examined the effects of early experiences on later personality development. Other investigators have studied the stability of particular patterns of personality over long periods of time. Their findings suggest that such tendencies as striving to achieve may persist to some degree from childhood into adulthood. However, research has also shown that personality continues to change as a result of new experiences and modifications in the environment.

Throughout their development, people learn about themselves and their world by observing other people and events. They also learn by trying new kinds of behaviour directly. The rewards and punishments they receive after trying various patterns of behaviour affect their future behaviour in similar situations. People also learn by observing the results of the behaviour of such social models as their parents. Suppose children repeatedly see adults succeed in antisocial or criminal acts. If they see such behaviour rewarded, they are more likely to copy it than if it is punished. Children more readily imitate models who are powerful or who reward or take care of them.

As children develop, they copy some of the behaviour of many models, including their friends as well as their parents. They combine aspects of their behaviour into new patterns. Through direct and observational learning and cognitive growth, they also acquire standards and values that help them regulate and evaluate their own behaviour. Gradually, people develop an enormous set of potential behaviours. The particular behaviour patterns they show in specific situations depend on motivational factors. See **Motivation.**

People's cognitive and social learning experiences vary as a result of the particular social and cultural conditions to which they are exposed in the home, at school, and in other environments. Personality traits may predict many important aspects of behaviour. But the setting in which behaviour occurs often provides the best predictions about what people will do. Thus, although extensive differences among people are found in most human actions, considerable uniformity and regularity can occur when environmental conditions are very powerful. Strong success experiences in a new situation, for example, may override the effects of past failure experiences and of personality traits in determining future reactions to that new situation. Similarly, prolonged or intense environmental changes, such as lengthy hospitalization or imprisonment, may lead to major personality changes. A person who has severe difficulties in personal relationships is said to be suffering from a personality disorder. See **Mental illness.**

**Emotional reactions.** During the course of development, we acquire intense emotional reactions to many stimuli. Events that once were neutral may become either pleasurable or painful as the result of conditioning (see **Learning** [How we learn]).

Some reactions may involve strong anxiety and can have crippling effects. For example, children who have frightening experiences with dogs may become afraid of all dogs. This fear may *generalize* (spread) even more widely to other animals and to such objects as fur coats, or hair. Such fears are especially hard to unlearn because these people tend to avoid all contact with situations that provoke fear. Consequently, these people prevent themselves from having experiences that might eliminate their fear—petting harmless dogs, for example. Emotional upsets of this kind may also be acquired by observing the fear reactions of other people.

As a result of social learning, we generalize from our experiences to new but similar or related situations. But we do not generalize indiscriminately. A young boy may learn to express physical aggression in many settings, including school, play, and home. But he also learns not to be aggressive in other situations, such as when visiting his grandparents.

**Personality change.** Research on cognitive and social learning processes is leading to new forms of psychotherapy to help people who have psychological problems. Some of these problems are the result of learning deficits. For example, some people lack fundamental academic and vocational skills, such as reading proficiency. Individuals who have inadequate relations with others need to learn essential interpersonal skills. Some people have these basic skills, but they suffer because of emotional fears and inhibitions.

Psychotherapy aimed at changing personality tends to stress insight into the history through which the problems developed. Learning methods try to change the disturbing behaviour itself by carefully planned relearning and conditioning techniques. Still other forms of personality change may be achieved by creating special environments for learning more adaptive personality patterns.

**Related articles** in *World Book* include:

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**Personification.** See **Figure of speech.**

**Personnel management** is a field of management that involves using workers' skills effectively and making their jobs rewarding. Many large businesses and other organizations have a department responsible for personnel management. The field is also called *employee relations* or *human resources management.* In organizations that have many employees who belong to a union, personnel management is often known as *industrial relations* or *labour relations.* Its chief function in such a company is to represent the firm in contract talks and other dealings with the union.

Specialists in personnel management have a wide range of responsibilities. They interview, test, and recommend applicants to fill job openings. They organize recruiting campaigns and travel to secondary schools and colleges to search for promising applicants. These managers develop pay scales, systems for evaluating employee performance, and training programmes to teach workers and managers new skills. They administer employee benefits, such as health insurance, life insurance, and pensions. They offer counselling to help employees solve personal or work-related problems. In many countries, personnel managers also supervise affirmative-action plans, including special recruiting and training programmes for women and minority groups (see **Affirmative action**).

**Development of personnel management.** In the 1800's and early 1900's, personnel management was a simple activity that involved little more than hiring employees. Recruiting was generally easy because many workers were competing for jobs.

Personnel management grew in complexity and importance during the mid-1900's. People began to recognize that worker morale affects productivity and that most workers need more than reasonable wages to be happy in their job. For example, employees also require recognition, a feeling of achievement, and an opportunity to participate in decisions that affect their work. Personnel managers helped meet these needs by such means as company newsletters, recreation programmes, and suggestion systems.

**Perspective** is a technique used by artists to give a picture the illusion of depth and distance. When observ-

Paint and gold on vellum (about 1450-1500) by Simon Marmion; Huntingdon Library, San Marino, California, U.S.A.

**Aerial perspective** creates an illusion of distance partly by emphasizing dark blue sky directly overhead and a lighter blue sky near the horizon.

*The Martyrdom of Savonarola* (1400's-1500's), an oil painting on wood panel by an unknown Italian artist

**Linear perspective** makes more distant objects smaller and places them closer together. The centre of the painting shown above illustrates the *vanishing point,* the spot at which parallel lines seem to meet in the distance.

ing a picture done in perspective, viewers have the impression that they are looking through a window. The sides of the picture serve as the "window frame." The scene appears to recede into the distance from a fixed point on the viewer's side of the window.

There are two major types of perspective in Western art—*aerial perspective* and *linear perspective*. Non-Western civilizations, such as those of China and India, have also developed styles of perspective. However, the Eastern styles do not produce an effect as realistic as the Western techniques.

Aerial perspective is based on the fact that light, shade, and colour change with an object's distance from the viewer. For example, distant objects appear hazier and less sharp in outline than objects seen nearby. The sky also changes from a deep blue directly overhead to an increasingly lighter blue as it approaches the horizon. An artist creates aerial perspective by varying the colour tones and the strength and sharpness of the picture's lines.

Linear perspective is a technique for showing distance and depth through the form, size, and position of objects. Linear perspective is based on the optical illusion that parallel lines seem to converge as they recede toward a *vanishing point*. A vanishing point is the spot at which the parallel lines appear to meet on the horizon. Linear perspective also creates the illusion of depth by making the more distant objects smaller and placing them closer together.

Artists in ancient Greece and Rome were the first to understand the principles of both aerial and linear perspective. Both techniques were largely abandoned during the Middle Ages, which began during the A.D. 400's. But perspective was rediscovered during the Renaissance, a cultural period that began in Italy during the 1300's.

Interest in perspective reached its peak in the Renaissance paintings of the 1400's and 1500's. About 1425, the Italian architect Filippo Brunelleschi painted two scenes of the city of Florence that used mathematical formulas to create perspective. His work had a great impact on Renaissance artists, who became fascinated with using perspective to achieve realism in portraying space. Leon Battista Alberti, another Italian architect, wrote *On Painting* (1435), the first scientific study of perspective. The Italian artist and scientist Leonardo da Vinci performed many experiments that explored how the eye sees objects at a distance.

For examples of perspective in art, see **Masaccio**; **Raphael**; and various paintings in the **Painting** article.

**Perspiration,** also called *sweat,* consists of water and certain dissolved substances produced by glands in the skin. Sweat glands are distributed over the entire surface of the body. But in certain areas they are larger and more concentrated. For example, there are many large sweat glands in the armpits, on the palms of the hands, and soles of the feet. The sweat glands are of almost no importance in ridding the body of waste materials. Their primary importance is to produce perspiration when the body needs to lose heat. Sweating itself does not reduce body heat. But when the sweat evaporates, it has a cooling effect. See **Evaporation**; **Temperature, Body.**

People perspire in cool weather as well as in warm, at night as well as during the day. When it is cool, the small amount of sweat produced evaporates almost as soon as it is formed. This is called *insensible* perspiration. When the weather is warm, or during strenuous exercise, body temperature tends to rise and the sweat glands increase their production. Then drops of water accumulate on the skin and we say a person is sweating. This is called *sensible* perspiration.

The *hypothalamus* (part of the brain which has the body's heat-regulating centre) keeps body temperature constant. It receives impulses from warm blood and from heat receptors in the skin. It sends signals by way of the nerves to the sweat glands, which then produce sweat. Nervous tension and excitement also activate the sweat glands, especially in the hands and armpits.

When the water of perspiration evaporates, certain solids (urea and salts) are left on the skin. Frequent bathing will keep these solids from accumulating and clogging the pores. Excess sweating in the armpits can be counteracted by applying various substances sold for this purpose. Most of these contain aluminium chloride.

Many animals do not reduce body heat in the way that human beings do. For example, a dog has sweat glands, but they are not important in reducing the body temperature. Many persons believe that a dog perspires through its mouth. But a healthy dog rarely perspires. Instead, it cools itself by panting.

See also **Deodorant; Elimination; Pore; Skin.**

**Perth** (pop. 1,143,265) is the state capital and business centre of Western Australia. The city spreads along a plain between the Indian Ocean to the west and the hills of the Darling Scarp to the east. Perth is 3,352 kilometres from Sydney. About 70 per cent of Western Australia's people live in Perth.

Perth is one of Australia's largest and most beautiful cities. It has well planned, tree-lined streets and splendid surfing beaches. The beautiful Swan and Canning rivers flow through the area. King's Park has 400 hectares of natural bushland. It also has a botanic garden designed to display the state's famous wildflowers and native plants.

The city of Perth, administered by the Perth City Council, contains the commercial and business area. The metropolitan area is the Perth statistical division, which covers an area of about 5,360 square kilometres, from the Shire of Wannereroo in the north to Rockingham in the south.

The climate of Perth is typically Mediterranean. This means Perth has wet, rather mild winters and hot, dry summers. In the summer, cool, anticlockwise ocean winds move inland over the Gibson Desert. When they flow back three days later, they are hot and searing. When the Perth region is not experiencing a heat wave, the *Fremantle Doctor,* a sea breeze, blows each afternoon. Unless it is influenced by a northerly cyclone, Perth receives no rain during the summer. The average rainfall is 870 millimetres a year. Perth's hottest month is February, when temperatures average 30° C. Its coldest month is July, with an average temperature of 17° C.

The first European to visit the present site of Perth was the Dutch navigator William de Vlamingh. He explored the Swan River in January 1697. James Stirling, a British naval officer, visited the area in 1827. On June 1, 1829, Stirling returned as lieutenant governor, with a group of settlers, to establish a new colony.

**Perth** is located on the beautiful Swan River. Perth's population has increased rapidly since World War II, and the city has many modern buildings.

### The city

The business and financial centre is the rectangle formed by St. George's Terrace and Barrack, Hay, and Irwin streets, the area occupied by the original Swan River Settlement in 1829. St. George's Terrace and adjoining Adelaide Terrace are the chief financial and business sectors of the city. Hay Street is one of the main commercial areas of Perth. A nearby cultural centre includes a museum, art gallery, and library.

Perth's main industrial centres include the large Kwinana-Rockingham complex south of Fremantle, the northeastern suburbs of Bayswater, Bassendean, and Midland Junction, and East Belmont and Welshpool south of the Swan River.

Residential areas were first established at Perth and Fremantle, and at Guildford, some distance up the river. In 1881, a railway linked Perth with Cottesloe, Claremont, and Fremantle. North Perth and Mount Lawley were developed in the 1890's. Between 1919 and 1940, considerable development took place both north and south of the Swan River, and along the Albany Highway to the east. Residential suburbs also began to appear in the Kalamunda area in the hills.

Town planning has played an important part in the growth of Perth. The city passed its first planning legislation in 1928. Rapid postwar development brought new problems. The solutions suggested by the Stephenson-Hepburn report of 1955 resulted in the Metropolitan Town Planning Scheme of 1959. This was followed by the Metropolitan Regional Scheme, which took in an even wider area. By 1966, it had become obvious that this scheme also needed modification because of the unexpected growth caused by the state's mineral boom.

A "corridor" scheme was developed to encourage the growth of subregional centres along northwest, southwest, east and southeast "corridors", and to reduce traffic congestion. This scheme was again modified in 1987 because these centres had failed to develop as hoped.

Perth does not have some of the problems faced by other Australian cities. Traffic congestion is the main problem, which was relieved to some extent by the construction of the Mitchell freeway. The Environmental Protection Authority monitors air and water quality.

**Buildings.** Although the Perth skyline is now dominated by high-rise, multistorey buildings, the city has retained a number of old buildings of historical and architectural interest. The earliest are the Court House in the Supreme Court Gardens, and the Round House, originally built as a jail, at Fremantle. Both are in a simple, modified Georgian style and were built in the 1830's by the first Australian civil engineer, H. W. Reveley. The Old Mill at Mill Point was built in 1835. Between 1850 and 1885, a number of dignified public buildings were erected in the Colonial Gothic style. They include Government House, the Town Hall, the Cloisters (originally a school), the Barracks (now partly demolished), St. George's Cathedral, and St. Mary's Catholic Cathedral, designed by Augustus Pugin. London Court shopping mall resembles a street in Tudor England.


**Education and the arts.** About three-quarters of primary and secondary pupils attend government schools, and a quarter attend nongovernment schools. Perth has five universities—the University of Western Australia, opened in 1911, Murdoch University, opened in 1975, and Curtin University of Technology (formerly the Western Australian Institute of Technology), opened in 1987. The Edith Cowan University developed from the Western Australian College of Advanced Education. It has campuses at Claremont, Midlands, Joondalup, Churchlands, and Mount Lawley, which also has an Academy of Performing Arts. Perth's youngest university, Notre Dame, is a private university. There are also many technical and further education colleges.

The State Library Service Building houses a lending and general reference library, the state film centre, and central music library. Perth Art Gallery has a fine collection of paintings, and there are also many fine private collections. Four drama theatres are located at the University of Western Australia. Music performances are given in the Perth Concert Hall, while popular entertainments, including sporting fixtures, are held in the Entertainment Centre, which has a seating capacity of 8,000.

As well as the Perth Museum, there is a Maritime Museum and Arts Centre at Fremantle located in the restored Old Woman's Home, built in the 1850's, which

**Perth's coat of arms** includes the shield of the city of Perth, Scotland, after which the city was named. The Latin motto, *Floreat,* means *May it flourish.*

houses relics from Dutch vessels wrecked off the west coast of Australia in the 1600's.

**People.** Perth's population has changed in size and character since World War II (1939-1945), mainly because of Australia's postwar immigration programme. About 70 per cent of the people now living in Perth were born there. Most of them are descendants of earlier English, Scots, and Irish immigrants. The largest number of post-war immigrants have also come from the British Isles. Next in number are immigrants from Italy, the Netherlands, Germany, Greece, and Vietnam.

**Economy.** Kwinana-Rockingham, with the nearby service town of Medina, was developed as a heavy industrial site during the mid-1950's. One of the largest oil refineries in Australia opened there in 1954, followed by a steel-rolling mill and a series of large metal, fuel, and chemical plants. Cockburn Sound was dredged to create a harbour. Electricity and a gas pipeline from the northern gasfield serve the area's energy needs. Power stations, strategically placed at East Perth, Kwinana, and Muja are connected by a grid with stations in the southwest and at Geraldton.

In the early 1960's, one of the world's largest alumina refineries began processing bauxite, mined at Jarrahdale. The area also has a cement works and a paper mill. In 1968, a multimillion-Australian dollar fertilizer plant was opened. The deep-draught loading terminal at Kwinana is one of the largest grain-shipping complexes in the world.

A variety of industries located within the boundaries of Perth City Council include a cement works, food and clothing factories, printing and publishing companies, and manufacturers of goods ranging from cranes and tractors to small components for electrical equipment. Western Australia's fishing industry, particularly of crayfish, is based at Fremantle, the port of Perth.

Water supply is a major problem because of Perth's hot, dry summers. The growth of suburbs since World War II has made the situation worse. Water is drawn from catchment areas in the Darling Range. Much of it comes from the Serpentine Pipehead Reservoir. Other reservoirs east and south of Perth include Canning, Mundaring, Wungong Brook, Churchman Brook, and Victoria reservoirs. North Dandalup Pipehead Dam and South Dandalup Reservoir also supply water to Perth.

The Serpentine Dam rises 55 metres above its foundations. It holds 177,600,000 cubic metres of water. The Canning River Dam rises 75 metres and has a capacity of 93,010,000 cubic metres. Perth can also draw water from the Gnangara sand beds and similar sources.

**Transportation and communication.** The railway system extends from Perth and Midland into the mining, agricultural, pastoral, and forest areas outside the metropolitan area. Transperth operates the metropolitan and suburban bus service, and a single ferry service to South Perth. Through Westrail, it operates four suburban railway lines. Private bus lines supplement the suburban network.

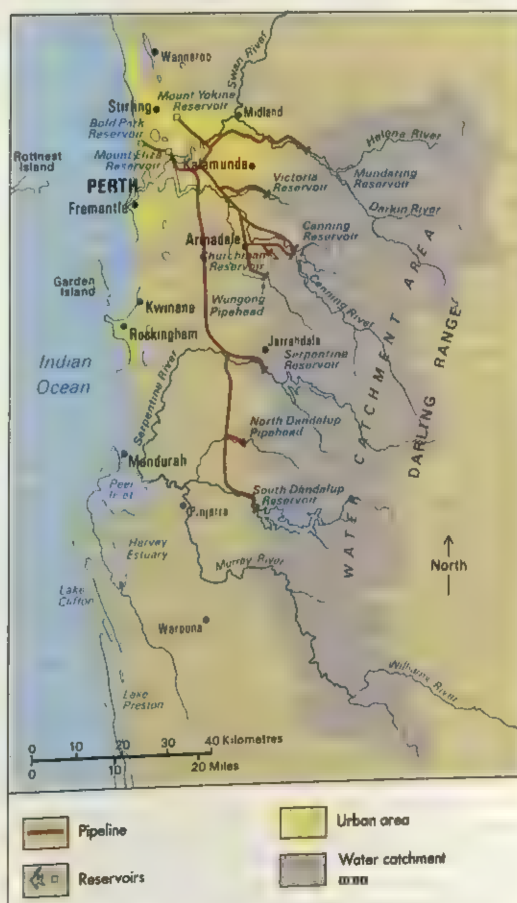
An international airport is located east of the city, at South Guildford. The Flying Doctor Service and private planes use Jandakot Airport.

Perth has two newspapers—*The West Australian,* a morning paper, and the *Sunday Times.* The metropolitan area is served by two Australian Broadcasting Corporation radio stations, four commercial radio stations, and one national and two commercial television stations.

**Government** is carried out by local authorities in cities, towns, and shires. They are responsible for the administration of welfare, pest control, vehicle licensing, maintenance of streets, drainage, removal of rubbish, and care of park areas.

## History

In 1829, Lieutenant Governor James Stirling and 69 settlers arrived in the ship *Parmelia* to establish a settlement. The first attempt, on Garden Island, was soon abandoned, and the new colony was formally declared on Aug. 12, 1829, on the site of the present Town Hall.




**The Perth water supply** flows from the Darling Range into reservoirs throughout the catchment area. Pipelines carry the water northward into the urban area.

**Fremantle** was selected as the port of Perth by Governor Stirling. This view of Fremantle was probably painted by Nicholas Chevalier in 1869.

Assignments of free land attracted many settlers. These grants ceased in 1830. Much of the land was sandy and unsuited to farming. Problems with the land and chronic labour shortages prompted the colonists to request the British government to declare Perth a penal settlement. Convicts, a source of free labour, began arriving in 1850, at a time when the other Australian colonies were phasing out transportation. Convicts continued to arrive till 1868.

Exploration of the hinterland behind Perth opened up farming land around Geraldton, and areas suitable for cattle and sheep near Esperance, and around the Gascoyne, Fortescue, and Ashburton rivers.

The Industrial Revolution in England sparked a demand for Australian wool. The prosperity that followed resulted in the construction of many fine public buildings. Queen Victoria proclaimed Perth a city in 1856. Between 1862 and 1868, Governor J. S. Hampton initiated an extensive building programme. It included Government House, the Town Hall, the Barracks, and a hospital.

In the 1870's, prosperous pastoralists and pearlers built elegant homes along the Swan River, especially at Guildford and Belmont. One of these homes, *Woodbridge,* was built by Charles Harper, and is now a National Trust property.

With the discovery of gold at Coolgardie in 1892 and at Kalgoorlie in 1893, Perth developed rapidly. Many new industries sprang up. Riverland was reclaimed and formed the Esplanade. Suburbs spread out to the north and east. In the 1910's, the city put in such improvements as gas and electricity, a proper sewerage system, and a water supply. Telephones were installed in many suburban homes. By 1919, the city had made plans for a Greater Perth by incorporating Leederville, North Perth, Monger's Lake, Victoria Park, and the Lime Kilns Estate. Roads were built to the coast, where people could enjoy a respite from the city heat.

Between 1918 and 1930, the city flourished, reflecting the prosperity of Western Australia. This was the result of the development of the wheat belt and large-scale dairying in the southwest. But 1930 brought a period of economic depression. Unemployment in Perth and elsewhere in Australia was the worst in its history. Farmers fled to the city, where they joined queues of people searching for work or waiting at soup kitchens.

**After World War II,** Perth was crowded and appeared run-down. Roads had fallen into disrepair, and public services had suffered because many of the workers had been occupied with defence work. But gradually, life returned to normal. A vigorous immigration policy increased the labour force and helped bring prosperity in the postwar years.

During the 1950's and 1960's, many new factories were built. Both residential and industrial suburbs grew rapidly. In the 1970's, the mineral boom in Western Australia brought further expansion to Perth.

In 1983, *Australia II,* owned by Western Australian entrepreneur Alan Bond, won the America's Cup yacht race. Fremantle was the site of the 1987 race, which attracted yachting enthusiasts and television crews from all over the world.

**Perth and Kinross** (pop. 126,842) is a large local government district in Tayside Region, Scotland. The district covers an area of 5,237 square kilometres. It has extensive areas of farmland, and beautiful moorland and mountain scenery. The River Tay, which flows through the district, is well known for its salmon fishing. Tourism is an important industry. In towns such as Perth, the district's administrative centre, whisky distilling and the manufacture of glass, dyes, and linen are the main industries. See also **Tayside Region.**

**Perthshire** was, until 1975, a county in eastern Scotland. See **Tayside Region.**

**Pertussis.** See **Whooping cough.**

Loren McIntyre from Woodfin Camp Inc.

**A pack train of llamas** transports goods in the rugged Peruvian Andes. Peru has great extremes of landscape and climate, ranging from snow-capped mountains to steaming jungles.

# Peru

**Peru** is the third largest country in South America. Only Brazil and Argentina cover a greater area. Peru is a land of enormous contrasts in landscape and climate. The country lies in western South America, along the Pacific Ocean.

The long, narrow coast of Peru consists of a desert even drier than the Sahara. Most of Peru's large cities lie in this region, including Lima, the capital and largest city, and its port, Callao. The towering, snow-capped Andes Mountains rise east of the coast and extend north and south along the entire length of the country. This region is famous for its grass-covered plateaus, crystal-clear air, and sparkling sunshine. Thick rainforests and jungles cover most of the hot, humid region east of the Andes. This region forms part of the Amazon basin.

More Indians, or native Americans, live in Peru than in any other country in South America. The Indians make up nearly half of the country's people and about a fifth of the total Indian population of North and South America. The rest of Peru's population consists mainly of people of mixed Indian and European ancestry.

Peru is one of the world's leading producers of copper, lead, silver, and zinc. It also ranks among the world's leading fishing countries. In the past, Peru's catch of fish was the largest in the world. But in the 1980's, many shoals of fish moved southward, out of Peruvian waters, and fishing declined. Most of Peru's people are poor. Many of them make a bare living farming. Other Peruvians work for low wages in the cities or are unemployed.

The ancestors of Peru's Indians include the famous Inca people, who built a great empire in Peru from the 1200's to the 1500's. The first European people to reach the country arrived in the 1520's, led by the Spanish adventurer Francisco Pizarro. They conquered the Inca in the 1530's and made Peru a Spanish colony. Peru declared its independence from Spain in 1821.

## Government

Peru has had several constitutions since it became independent in 1821. The latest was adopted in 1993. Each constitution declared the country to be a democratic republic. Yet dictatorships have ruled Peru many times, including during the period from 1968 to 1980. In 1968, military leaders overthrew Peru's constitutionally elected leaders and took control of the government. The military leaders suspended the constitution, dismissed the legislature, and cancelled all elections. In 1980, elections were held for a new democratic civilian government. The new government replaced the revolutionary

### Facts in brief about Peru

**Capital:** Lima.
**Official languages:** Spanish and Quechua.
**Official name:** República del Perú (Republic of Peru).
**Area:** 1,285,216 km². *Greatest distances*— north-south, 1,971 km; east-west, 1,408 km. *Coastline*—2,330 km.
**Elevation:** *Highest*—Huascarán, 6,768 m above sea level. *Lowest*—sea level along the coast.
**Population:** *Estimated 1996 population*—24,314,000; density, 19 people per km²; distribution, 72 per cent urban, 28 per cent rural. *1981 census*—17,702,400. *Estimated 2001 population*—26,741,000.
**Chief products:** *Agriculture*—bananas, coffee, cotton, potatoes, sugar cane. *Fishing*—anchovies, sardines. *Manufacturing*—fish meal, metals, sugar, textiles. *Mining*—copper, iron ore, lead, petroleum, silver, zinc.
**Money:** *Currency unit*—nuevo sol. One sol = 100 centimos.

government. It was headed by a president. A legislature made the country's laws.

**National government.** In 1992, Peru's president, Alberto Fujimori—with the backing of the military—suspended the constitution, dissolved the legislature, and disbanded regional assemblies. Fujimori began to rule Peru by decree. In late 1992, popular elections were held to form an 80-member Constituent Assembly. The Assembly wrote a new constitution for Peru that was approved in December 1993.

The constitution was to take effect in 1995. That year, a new presidential election and legislative elections were scheduled to take place. Fujimori and the Constituent Assembly that was elected in 1992 were to serve until the 1995 elections. The government that was outlined in the 1993 constitution was to include a president, two vice presidents, a one-house legislature called Congress, and a cabinet.

Under the civilian government that operated prior to suspension of the old constitution, the people elected Peru's president to a five-year term. Peru's legislature consisted of two houses, a 60-member Senate and a 180-member Chamber of Deputies. The people elected all members of the legislature to five-year terms.

The Supreme Court was Peru's highest court. It was located in Lima.

**Local government.** Peru is divided into 12 regions for purposes of local government. In 1992, Fujimori dissolved the regional assemblies that governed these regions. The regional assemblies are scheduled to be restored in 1995. Peru's 12 regions are further divided into provinces, and the provinces are divided into districts.

**The armed forces**—especially the army—have traditionally played an important role in Peruvian life. Besides being deeply involved in politics, members of the armed forces assist in such activities as police work and road building. The army, navy, and air force total nearly 130,000 people. The officers are highly trained and well educated. Some Peruvian men are conscripted for two years of military service at age 20.

**Government Palace** in Lima houses the office of Peru's president. The building was erected in 1938 on the site of a palace built by the Spanish conqueror Francisco Pizarro in the 1500's.

**Peru's state flag,** used by the government, was adopted in 1825. The unofficial national flag has no shield or wreath.

**Coat of arms.** The symbols on the shield represent Peru's abundant animal, plant, and mineral resources.

## People

**Population.** Peru has a population of about 23 million people. About two-thirds of the people of Peru live in cities or towns. The rest live in rural areas. Lima is by far the largest, busiest, and most modern Peruvian city. Lima and the neighbouring city of Callao make up *Greater Lima.* Callao and the city of Arequipa are next to Lima in size. Two other Peruvian cities are Trujillo and Chiclayo. See the list of *Related articles* at the end of this article.

**Ancestry.** After the Spanish conquest of Peru in the 1500's, some Spaniards and Indians married. Their descendants are called *mestizos.* Today, it is estimated that about 43 per cent of all Peruvians are mestizos. About 46 per cent of all Peruvians are Indians. People of European descent make up about 10 per cent of Peru's population. Most of these people are of Spanish ancestry. Peru also has people of African and East Asian descent. They make up less than 1 per cent of the country's population.

**Languages.** Spanish became Peru's official language soon after the Spanish conquest and remained the only official language for several hundred years. In 1975, the Peruvian government made Quechua, the language of


**Peru** lies in western South America along the South Pacific Ocean. It is the continent's third largest country.


## Cities and towns

| | | | |
|---|---|---|---|
| Abancay | 24,907 | E | 4 |
| Andahuaylas | 18,197 | E | 4 |
| Arequipa | 591,700 | F | 4 |
| Ayacucho | 94,200 | E | 3 |
| Ayaviri | 15,984 | E | 4 |
| Azángaro | 22,476 | E | 5 |
| Barranca | 51,200 | D | 2 |
| Cajabamba | 22,676 | C | 2 |
| Cajamarca | 85,600 | C | 2 |
| Callao | 560,000 | D | 2 |
| Camaná | 12,535 | F | 4 |
| Catacaos | 30,000 | B | 1 |
| Celendín | 18,168 | C | 2 |
| Cerro de Pasco | 72,100 | D | 3 |
| Chachapoyas | 12,800 | C | 2 |
| Challabamba* | 5,703 | E | 4 |
| Chancay | 29,400 | D | 2 |
| Chepén | 33 700 | C | 2 |
| Chiclayo | 394,800 | C | 1 |
| Chimbote | 278,600 | C | 2 |
| Chincha Alta | 49,300 | E | 3 |
| Chocope | 29,287 | C | 2 |
| Chota | 36,190 | C | 2 |
| Chulucanas | 44,600 | B | 1 |
| Cusco | 255,300 | E | 4 |
| Ferreñafe | 31,000 | C | 2 |
| Huacho | 85,000 | D | 2 |
| Huamachuco | 26,849 | C | 2 |
| Huancané | 27,035 | E | 5 |
| Huancavelica | 24,700 | E | 3 |
| Huancayo | 199,200 | D | 3 |
| Huánuco | 85,500 | D | 3 |
| Huaral | 53,600 | D | 2 |
| Huaraz | 61,200 | D | 2 |
| Huayllabamba* | 4,185 | E | 4 |
| Ica | 144,000 | E | 3 |
| Ilabaya | 12,377 | F | 4 |
| Ilave | 36,930 | F | 5 |
| Ilo | 39,900 | F | 4 |
| Imperial | 23,855 | E | 3 |
| Iquitos | 205,568 | B | 4 |
| Jaén | 35,100 | B | 2 |
| Jauja | 18,100 | D | 3 |
| Juliaca | 120,900 | E | 5 |
| Junín | 10,354 | D | 3 |
| Lagunas | 9,167 | B | 3 |
| Lambayeque | 33,400 | C | 1 |
| La Oroya | 43,900 | D | 3 |
| La Unión | 18 054 | D | 2 |
| Lima | 5,493,900 †6,053,900 | D | 2 |
| Mollendo | 26,700 | F | 4 |
| Moquegua | 29,400 | F | 4 |
| Motupe | 16,050 | C | 2 |
| Moyobamba | 22,900 | C | 2 |
| Nazca | 25,200 | E | 3 |
| Paiján | 15,856 | C | 2 |
| Paita | 36,100 | B | 1 |
| Paramonga* | 36,600 | D | 2 |
| Pativilca | 15,863 | D | 2 |
| Pimentel* | 14,456 | C | 2 |
| Pisco | 74,200 | E | 3 |
| Piura | 297,200 | B | 1 |
| Pucallpa | 140,700 | C | 3 |
| Puno | 92,700 | F | 5 |
| Requena | 12,643 | B | 3 |
| San Pedro de Lloc* | 13,563 | C | 2 |
| San Vicente de Cañete | 22,957 | E | 3 |
| Saña | 34,980 | C | 2 |
| Santa* | 29,000 | C | 2 |
| Sullana | 145,500 | B | 1 |
| Tacna | 137,500 | F | 5 |
| Talara | 81,400 | B | 1 |
| Tarapoto | 65,000 | C | 3 |
| Tarma | 47,500 | D | 3 |
| Tingo María | 39,800 | D | 3 |
| Trujillo | 491,100 | C | 2 |
| Tumbes | 61,100 | B | 1 |
| Yanahuara | 15,412 | F | 4 |

# Peru map index

## Departments*

| Name | Population | Area in sq. mi. | Area in km² | Map key |
|---|---|---|---|---|
| Amazonas | 319,500 | 15,945 | 41,297 | B 2 |
| Ancash | 951,800 | 14,019 | 36,308 | D 2 |
| Apurímac | 364,800 | 7,975 | 20,655 | E 4 |
| Arequipa | 910,500 | 24,528 | 63,528 | F 4 |
| Ayacucho | 557,600 | 17,569 | 45,503 | E 3 |
| Cajamarca | 1,222,600 | 13,675 | 35,418 | C 2 |
| Callao (Constitutional Province) | 560,000 | 29 | 74 | D 2 |
| Cusco | 1,000,400 | 32,487 | 84,141 | E 4 |
| Huancavelica | 372,900 | 8,831 | 22,871 | E 3 |
| Huánuco | 583,800 | 13,635 | 35,315 | D 3 |
| Ica | 519,500 | 8,205 | 21,251 | E 3 |
| Junín | 1,062,600 | 12,492 | 32,354 | D 3 |
| La Libertad | 1,180,800 | 8,973 | 23,241 | C 2 |
| Lambayeque | 881,000 | 6,404 | 16,586 | C 1 |
| Lima | 6,313,000 | 13,087 | 33,895 | D 3 |
| Loreto | 621,800 | 131,919 | 341,669 | B 3 |
| Madre de Dios | 46,000 | 30,272 | 78,403 | D 4 |
| Moquegua | 126,800 | 6,245 | 16,175 | F 4 |
| Pasco | 270,800 | 8,438 | 21,854 | D 3 |
| Piura | 1,413,600 | 12,767 | 33,067 | B 1 |
| Puno | 997,400 | 27,947 | 72,382 | F 5 |
| San Martín | 429,500 | 20,488 | 53,064 | C 3 |
| Tacna | 195,500 | 5,702 | 14,767 | F 4 |
| Tumbes | 135,900 | 1,827 | 4,732 | B 1 |
| Ucayali | 217,700 | 52,768 | 136,667 | C 3 |

*Department names and names of cities and towns marked with an asterisk do not appear on map; key shows general location.
†Population of metropolitan area.
Sources: 1988 official estimates for departments and largest cities; 1981 census for other places.

the Inca, an official language along with Spanish.

About 75 to 80 per cent of all people in Peru speak Spanish. The rest speak only an Indian language. Quechua is by far the most common Indian tongue. About 2 million Indians who live in the highland region—that is, the highest parts of the Peruvian Andes—speak only Quechua. A much smaller number of highland Indians speak Aymara, the language of a tribe conquered by the Inca in the 1400's. In the rain forests and jungles of eastern Peru—a region called the *selva*—scattered groups of Indians speak a variety of other tribal languages. Many Peruvians speak both Spanish and an Indian language.

**Ways of life.** Peru's Spanish conquerors established a strict class system that was based on ancestry. A small upper class, made up of whites, controlled a huge lower class, made up of Indians. As the number of mestizos grew, most of them also became part of the lower class. This two-class system lasted until about 1900, when a small middle class of whites and mestizos began to develop.

Peru's middle class has grown steadily during the 1900's. Today, it includes office workers and managers, professional people, owners of small businesses, and military officers. But the great majority of Peruvians—that is, almost all Indians and most mestizos—still belong to the lower class. Peru's small upper class still consists almost entirely of whites.

***Whites.*** About half of Peru's whites belong to the upper class, and about half to the middle class. A few Peruvian whites belong to the lower class. The whites speak Spanish and dress much as people do in other Western countries.

Family ties are important at every level of Peruvian society. But they are especially important among upper-class white families, who have traditionally controlled much of the country's wealth. These families seldom mix with people outside their class, and in most cases their children marry into other upper-class families. Most of the families live in fashionable sections of Lima and other large cities.

***Mestizos,*** like whites, speak Spanish and wear Western-style clothing. They have always had closer ties with the white community than Indians have had. For example, white owners of mines and plantations traditionally hired mestizos to supervise Indian workers. The growth of the middle class has given mestizos other opportunities for advancement. Today, many middle-class mestizos attend college and become leaders in government, industry, the armed forces, and the professions. A few mestizos have even acquired enough wealth and social standing to be accepted into the upper class. But the majority remain in the lower class.

***Indians.*** Most of Peru's Indians live in the highlands and on the coast. A much smaller number live in the selva. Nearly all the Indians are poor, and most of them lack a formal education.

The highland Indians live at elevations of up to 4,570 metres. The Himalaya—the great mountain system of southern Asia—is the only other place in the world where people live at such high altitudes. Almost all highland Indians live by farming. Most of the young people wear Western-style clothing. However, many of the older Indians wear traditional garments of hand-

**An Indian family** in northeastern Peru's hot, humid rain forest needs only a thatched roof for shelter. More Indians live in Peru than in any other country in South America.

woven cloth. See **Clothing** (Traditional costumes).

The Indians of the selva belong to about 40 tribes. They live in scattered tribal villages, wear little clothing, and hunt and fish for most of their food.

Over the years, many Indians have moved from the highlands and selva to work on coastal plantations. Numerous other Indians have moved to the cities. But many of them have been handicapped by their lack of schooling and inability to speak Spanish.

**Housing.** Most rural families in Peru build their own houses. The typical house has one room. In the highlands, most houses have walls of *adobe* (sun-dried clay brick) and a roof of grass thatch or handmade tile. Most homes in the selva have walls built of twigs or bamboo poles and a roof of grass or palm thatch.

Many kinds of housing can be found in Peru's large cities. In upper- and middle-class neighbourhoods, the people live in comfortable single-family homes with enclosed patios. The largest cities also have high-rise apartments and modern public housing. But much city housing in Peru is extremely poor.

Many lower-class families in Lima and other large cities live in crowded, unsanitary slums. But since the 1950's, thousands of families have left the slums and started *squatter* communities on public land outside the cities. Today, nearly a million Peruvians live in such communities.

Most squatters first build their home of cardboard, old metal, and other scrap. But because squatters do not pay rent, many families save enough money in time to build a permanent house of adobe or concrete blocks. To encourage these efforts, the government has named the squatter communities *pueblos jovenes* (young, or new, towns) and supplied some with running water and a sewerage system.

**Food.** Most upper- and middle-class families in Peru eat a varied diet of meat, fish, poultry, vegetables, and

**A modern section of Lima,** with its motorway and high-rise apartment buildings, resembles the newer sections of large cities throughout the world. Lima is Peru's largest city by far.

**Collecting the family water supply** is an everyday chore in many poor sections of Lima. These Indians live in an improved slum area called a *pueblo joven* (young, or new, town).

**Public religious celebrations,** such as this Holy Week procession in Ayacucho, attract great crowds of worshippers. Almost all Peruvians belong to the Roman Catholic Church.

cereal products. They highly season many main dishes with onions and hot peppers. Rice, potatoes, and bread accompany most main meals.

The majority of lower-class families in Peru, especially most highland Indians, have a poor and monotonous diet. The diet of the highland Indians consists largely of potatoes, beans, maize, squash, and soups made of barley or wheat. Many highland Indians chew the leaves of the coca plant. Coca leaves contain the drug cocaine, which relieves feelings of hunger (see **Coca**). The Indians of the selva have a somewhat more varied diet. These Indians raise only a small number of crops, such as maize and *cassava,* a starchy root. However, the jungle provides the Indians of the selva with many varieties of fish and small game and several different types of fruits and nuts.

**Recreation.** Music and dancing are extremely popular throughout Peru. Radio stations play everything from traditional Peruvian music to the latest hit tunes from the United States. Traditional Indian music is performed on drums, flutes, rattles, and a kind of small harp. Mestizo music also uses these instruments plus such others as guitars, fiddles, and horns. Mestizo bands attract large crowds in cafes and dance halls throughout Peru. Films are also a popular form of recreation in Peru.

Soccer, which Latin Americans call *fútbol,* ranks as the most popular sport in Peru. The country's national soccer team plays against teams from other countries in Lima's 70,000-seat National Stadium. Many Peruvians also enjoy basketball and bullfights.

Almost every city and town in Peru holds an annual festival, called a *feria,* to honour its patron saint. Ferias include colourful religious processions, feasting, dancing, and games. Peru celebrates the anniversary of its independence on July 28.

**Education.** About one-fourth of all Peruvians 15 years of age or older cannot read or write. The great majority of these people live in rural areas, and most are Indians. Most educated Peruvians live in the cities, which have by far the greatest number of schools. Since the early 1960's, the government has built many rural primary schools. But many more are needed.

Peruvian law requires all children between the ages of 6 and 15 to attend school. But many rural children cannot meet this requirement because of a shortage of schools and teachers. Most primary and secondary school students attend free state schools. Nearly all students from middle- and upper-class families go to private schools, which charge a tuition fee. Peru has about 30 universities, including the famous University of San Marcos in Lima. Founded in 1551, it is the oldest institution of higher learning in South America (see **San Marcos, University of**).

**Religion.** About 95 per cent of all the people of Peru are Roman Catholics. However, relatively few people attend church regularly. Many Indian Catholics still worship Inca gods. The Peruvian government grants freedom of worship to all religious groups, but it officially favours the Roman Catholic religion. For example, the Catholic religion is taught in state schools throughout the country. Other religious groups in Peru include Protestants, Jews, and Buddhists.

**The arts.** Peru's artistic traditions date back nearly 3,000 years, when the country's Indians began to create

**A village school,** one of many opened in Peru since the early 1960's, helps rural Indian children learn to read and write. In the past, few of the country's Indians received any schooling.

beautiful sculpture, pottery, jewellery, and textiles. Peru's Indians still practise these arts and crafts. The Inca were expert architects. Examples of their architectural skill can be seen in many parts of Peru.

The Spanish colonists constructed many richly decorated churches and public buildings in Peru. Earthquakes have destroyed many of these structures. But some have been rebuilt. For examples of the Spanish colonial style of architecture, see **Lima** (picture: The Plaza de Armas).

The first great Peruvian writer was Ricardo Palma, who wrote during the last half of the 1800's and the early 1900's. Palma won fame throughout the world for his stories about life in colonial Peru. Later in the 1900's, many talented Peruvian authors championed the cause of the Indian. These writers include the political writer José Carlos Mariátegui, the poet César Vallejo, and the novelists Ciro Alegría and José María Arguedas. During the 1960's and 1970's, Mario Vargas Llosa became famous for his novels about the relations between Peru's social classes.

## Land regions

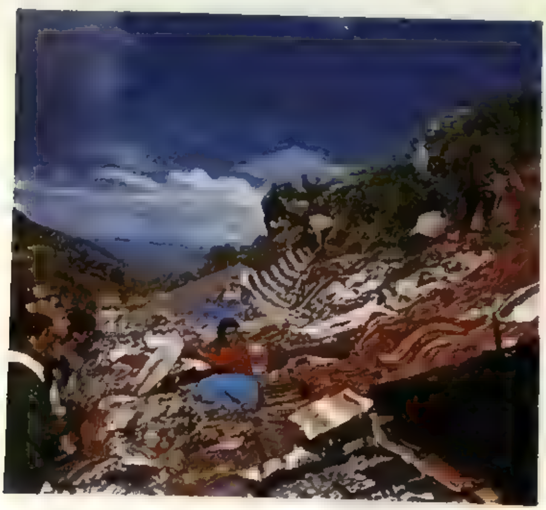
Peru has three main land regions. They are, from west to east: (1) the coast, along the Pacific Ocean; (2) the highlands, the highest parts of the Peruvian Andes; and (3) the selva, a region of forests and jungles. Earthquakes occur frequently in Peru. Most of them centre in the highlands, and their effects extend to the coast. A terrible earthquake in 1970 killed more than 66,000 people, chiefly in the northern highlands.

**The coast** consists of a long, narrow strip of land between the Pacific Ocean and the highlands. The region includes the western foothills of the Peruvian Andes. Most of Peru's large cities, commercial farms, and factories lie along the coast. Nearly all the coast is dry, rugged desert. But about 50 rivers, which flow from the mountains, cross the region. The rivers provide irrigation water for coastal farms as well as drinking water for the towns and cities.

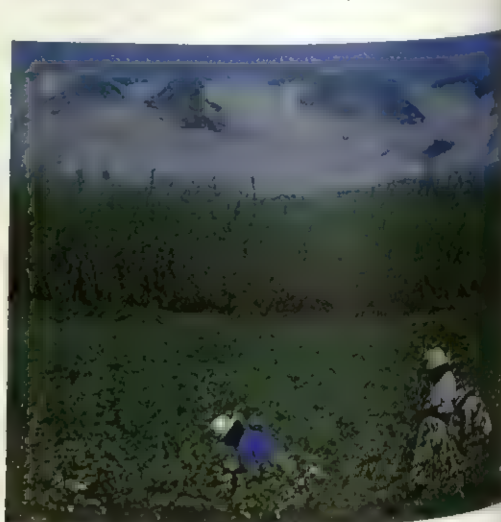
**The highlands** consist of all areas of the Andes Mountains above about 2,000 metres. Broad valleys and plateaus make up much of the region. The tallest highland peaks have snow all year round, and some have permanent glaciers. The highest peak is 6,768-metre Huascarán, an extinct volcano. Few trees grow in the highlands. But many of the valleys have a thick cover of grass. The Indians use these valleys for grazing herds of livestock, especially llamas and sheep. See **Andes Mountains.**

Lake Titicaca, in the southern highlands, is Peru's largest lake. Part of the lake lies in Bolivia. The Peruvian part covers 4,957 square kilometres. Lake Titicaca lies 3,812 metres above sea level. It is the highest navigable lake in the world, and its shores are densely settled by Aymara Indians. See **Lake Titicaca.**

**The selva** has two subregions—the high selva and the low selva. The *high selva* consists of the eastern foothills of the Andes. Unlike the dry western foothills,



**Colourful handwoven goods,** like these displayed for sale beside a road near Cusco, have been produced in Peru for nearly 3,000 years. Peru's craftworkers are famous for their artistry.



**Peru's coastal desert** consists largely of barren land like the sand-covered hills in the background. But with irrigation, the land produces cotton, *foreground,* and other crops.

the eastern foothills are covered with green forests. The *low selva* consists of low, flat plains east of the high selva. Thick rain forests and jungles cover almost all the low selva. The mighty Amazon River, South America's longest river, flows through this region (see **Amazon River**).

## Climate

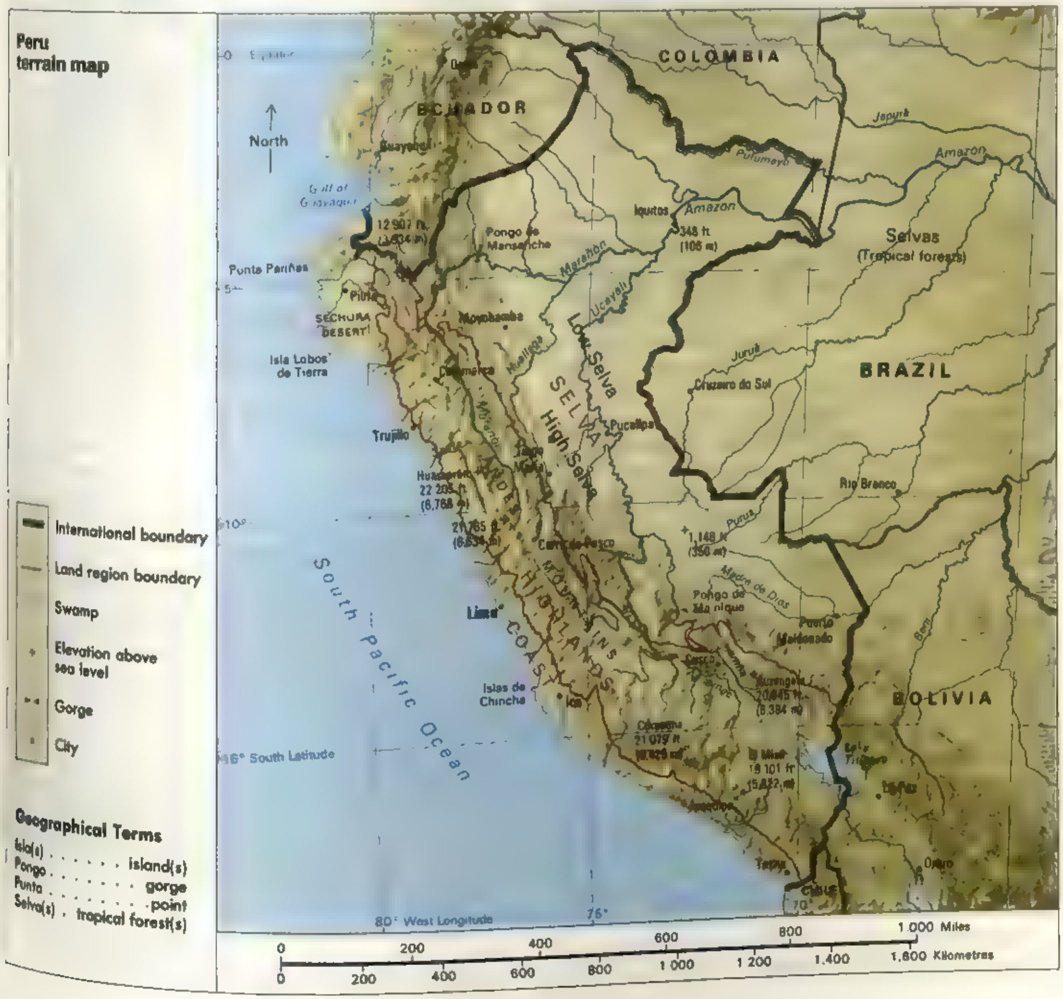
Peru lies entirely within the tropics. But the Peru Current, an unusually cold ocean current, makes the coast cooler than is normal for a tropical region (see **Peru Current**). Coastal temperatures average 23° C from November to April and 16° C from May to October. Because of the high altitudes, temperatures in the highlands range even lower than do coastal temperatures. At the highest elevations, the temperature never rises above freezing and the mountain peaks are snow-capped. But at elevations below about 3,000 metres, frosts never occur. Most of the selva has high temperatures throughout the year. In many places, the temperature averages nearly 27° C.

The amount of rain, snow, and other forms of *precipitation* increases greatly from the coast to the selva. Because the air along the coast is cool, it cannot hold much moisture. In addition, air from the wet east loses its moisture in the Andes before it reaches the coast. As a result, the coast seldom receives more than 5 centimetres of rainfall a year. Many parts of the western highlands have less than 25 centimetres of precipitation each year.

The eastern highlands and the selva have a wet season from November to the end of April and a dry season from May to the end of October. Much of the eastern highlands receives more than 100 centimetres of precipitation a year. Most of the selva has at least 200 centimetres of precipitation annually, and some parts of the high selva are drenched with more than twice that amount.

## Economy

In the past, upper-class families controlled most of Peru's resources and industries. In 1968, a military government took power. The military leaders took over some businesses and gave part ownership of some farms and factories to the employees. In 1980, Peru returned to civilian rule. The civilian government began increasing private ownership. Government leaders hoped that increased private enterprise might relieve some of



Peru's economic problems, including rapid inflation, high unemployment, and low productivity. But the government has been slow to carry out its policies, and the problems have continued.

**Agriculture.** Farming is the chief occupation in Peru. Many farming families own a small plot of land on which they produce barely enough to feed themselves. Others work on large *cooperative* farms. On such farms, the workers own and operate the farm as a group.

Coffee, cotton, and sugar cane are Peru's chief export crops. Highland farms produce most of the coffee. Irrigated farms along the coast grow most of the cotton and sugar cane. Most other crops are grown mainly to meet the country's own food needs. These crops include bananas, beans, maize, potatoes, and rice.

**Mining.** Peru is one of the world's leading producers of copper, lead, silver, and zinc. All these minerals are mined mainly in the highlands. The country also produces a considerable amount of iron ore and petroleum. The richest iron mines lie on the far south coast. The north coast and the selva have the largest petroleum deposits. The highlands have important gold deposits.

About 40 small islands off the Peruvian coast have large deposits of *guano* (bird droppings), which makes a good fertilizer as it is rich in nitrates and phosphates. A government company mines the guano and sells it to mainland farmers. See **Guano.**

**Fishing.** Peru is one of the leading fishing countries. Each year, the country's fishing fleets catch large quantities of anchovettas, sardines, tuna, and other sea fish. Sardines make up by far the largest catch. Fish meal made from dried Peruvian sardines and anchovettas is sold throughout the world for use in livestock feed.

To avoid overfishing and thereby ensure a profitable catch by Peruvian vessels, Peru claims authority over waters up to 370 kilometres off its coast. The government charges foreign vessels a high fee to fish in these waters and seizes vessels that refuse payment. This practice has caused a number of clashes between foreign fishing vessels and Peruvian authorities.

**Manufacturing.** Much manufacturing in Peru is done on a small scale by individual craftworkers. But some manufacturing plants, mainly along the coast, have many workers and use mass-production methods. Many of these plants process raw materials for export. The chief processed goods include fish meal, petroleum products, refined metals, and sugar. Other large factories produce chemicals, furniture, paper products, processed foods, steel, and cotton and woollen textiles.

**Trade.** Peru's leading exports include fish meal, petroleum, and minerals, especially copper and silver. The country also exports coffee, cotton, and sugar. Imports include machinery, motor vehicles, other manufactured goods, dairy products, meat, and wheat.

The United States has long been Peru's chief trading partner. But since the 1950's, Peru has increased its trade in South America and with Europe and Japan.

**Transportation.** Travel across Peru is hindered by the rugged Andes. Most of the country's roads are rough and unpaved. Peru has an average of about 1 car for every 50 people. The Peruvian section of the Pan American Highway is the longest paved road. It extends 2,752 kilometres along the coast (see **Pan American Highway**). A branch of the highway extends southeastward from the coast into Bolivia. A number of side roads run eastward from the highway into the highlands, and some continue into the selva. But most travel in the selva is by river. Llamas often serve as pack animals in the highlands. Peru has two airlines. Their flights connect Lima with all parts of Peru and with other Latin-American countries.

The Central Railway extends from Greater Lima to the mines and ore refineries high in the Andes. It climbs 4,829 metres above sea level, higher than any other standard-gauge railway in the world. The Southern Railway connects the port of Mollendo with Arequipa and other cities and towns in the southern highlands. For a picture of the Central Railway and more information on transportation in Peru's highlands, see **Andes Mountains.**

Peru has few good natural harbours. But some harbours have been developed into important seaports. Callao is the chief international port.

**An opencast mine high in the Andes** produces copper, lead, and zinc. Peru has enormous mineral deposits, and mining plays a major role in the country's economy.

**Workers in a fish-processing plant** near Piura handle part of Peru's enormous annual catch of sea fish, *above*. Fishing is a leading industry in Peru.

**Communication.** Lima has about seven daily newspapers, and most other cities have at least one. Most Peruvian newspapers are privately owned, and they represent a variety of political viewpoints.

Radio is an important means of mass communication in Peru. Most Peruvian families own a portable radio. Programmes are broadcast in Spanish and Quechua. Peru has an average of about 1 television set for every 10 people. Many people watch television in public places. Television offers both local programmes and foreign programmes with Spanish soundtracks. The government operates some radio and television stations. Others are privately owned. The government owns and operates Peru's postal system.

## History

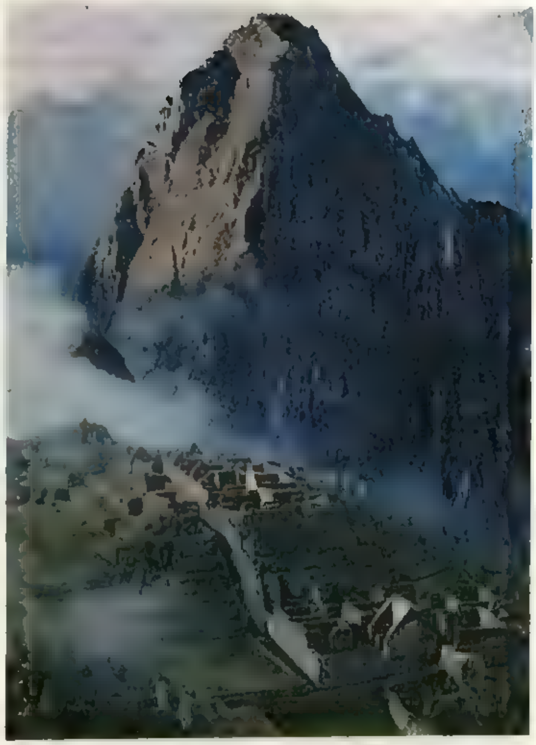
Scholars believe that the first people to live in Peru were Indians who arrived from North America about 12,000 years ago (see **Indian, American** [Early days]). Gradually, the Indians learned to farm. They tamed the llama and began to cultivate the potato, which grew wild in the highlands. Potatoes became an important food in Peru long before they were known anywhere else in the world (See **Potato** [History]).

The Chavin Indians established the first known civilization in Peru. It reached its peak about 900 B.C. Later, other groups, such as the Mochica, Tiahuanaco, and Chimu, also established civilizations in Peru. The Chimu built a large capital city called Chanchan. It was begun in about A.D. 1000. Chanchan's ruins cover about 20 square kilometres near present-day Trujillo.

In about 1200, a people called the Inca founded a kingdom in southern Peru. The Inca were master architects and roadbuilders and competent astronomers. They were also dedicated lawmakers and warriors. By the early 1500's, the Inca had built a great empire, and their civilization had reached its peak. The Inca rule extended northward into parts of present-day Colombia and Ecuador and southward as far as present-day Chile and Argentina. For detailed information about the Inca empire, see **Inca.**

**Spanish conquest and rule.** In the mid-1520's, the Spanish adventurer Francisco Pizarro began to explore the west coast of South America. He had heard tales of the Inca empire and of its treasures of silver and gold. In about 1527, Pizarro and a few followers landed near the Inca city of Tumbes on Peru's north coast. They became the first white men to set foot in Peru.

**Chanchan,** capital of the Chimu Indians, lies in ruins near Trujillo. The Chimu were part of a long series of civilizations that flourished in Peru before the Spaniards came in the 1500's.



**The ruins of Machu Picchu,** once a walled Inca city, stand near Cusco. The Inca, who built Peru's last great Indian civilization, were conquered by the Spaniards in the 1530's.

Pizarro saw enough riches at Tumbes to convince him that the legends about the Inca were true. He returned in 1532 with about 180 men, who were later joined by other Spanish troops. By the end of 1533, the Spanish had easily conquered most of Peru, including the fabulous city of Cusco, the Inca capital. In 1535, Pizarro founded Lima. It became the centre of the Spanish government in Peru and throughout South America. For the story of the Spanish conquest of Peru, see **Inca** (History); **Pizarro, Francisco.**

Spain ruled Peru for nearly 300 years. During this time, thousands of colonists arrived from Spain to seek their fortune. Soon after the conquest, the king of Spain appointed a *viceroy* (governor) to enforce Spanish laws and customs. The Indians had to become Christians and take Spanish names. Whole families were forced to work on plantations and in mines.

Peru quickly became one of Spain's most profitable colonies. But from time to time, Indians and *mestizos* (people of mixed Indian and Spanish ancestry) rebelled against the harsh white rule. A widespread revolt broke out in 1780. It was led by a mestizo who called himself Tupac Amaru, after one of the last great Inca leaders. The Spaniards captured and executed him in 1781 and crushed the uprising the following year.

**The war of independence.** The chief heroes of Peru's independence from Spain were José de San

Martín of Argentina and Simón Bolívar of Venezuela. They wanted to end European rule throughout South America, and Peru became one of their main targets. Most Peruvians took little or no part in the independence movement. The white upper class benefited from Spanish rule, and the Indians expected to gain little if Peru became independent.

San Martín invaded Peru in 1820 with an army of Argentines and Chileans. He declared the country independent in 1821, though much of it remained under Spanish control. Bolívar led an army of Venezuelans and Colombians into Peru in 1823. The next year, Antonio José de Sucre, one of Bolívar's generals, defeated a large Spanish force at Ayacucho in south-central Peru. The remaining Spanish troops held only the city of Callao. They finally surrendered in 1826. Although Peru had become free, Spain did not formally recognize its independence until 1879.

**The early republic.** Peru's first constitution went into effect in 1827. It declared Peru a democratic republic. Also in 1827, the legislature elected General José de la Mar as Peru's first president. He became the first in a long series of military officers who held the presidency during most of the 1800's. Many of the military presidents seized office in armed uprisings. The most important of these presidents was General Ramón Castilla.

Castilla became one of the first mestizos to hold high public office in Peru. He served as president from 1845 to 1851 and from 1855 to 1862. Castilla developed the guano industry and opened trade with Europe and the United States. He also ended the *tribute* (tax) that Indian workers had to pay their employers.

**The War of the Pacific** cost Peru its valuable nitrate deposits. Nitrates are minerals used in making fertilizer and explosives. The War of the Pacific began as a quarrel between Bolivia and Chile over control of certain Bolivian nitrate deposits. As a result of the dispute, Chile invaded Bolivia in 1879, marking the start of the war. Peru entered the conflict as an ally of Bolivia.

Chilean troops occupied Lima in 1881 and seized Peru's nitrate-rich southern provinces of Tacna, Arica, and Tarapacá. Chile also took Bolivia's coastal and desert lands around the city of Antofagasta. The Treaty of Ancón ended the war in 1883. The treaty allowed Chile to keep the captured Peruvian provinces, but Chile returned Tacna to Peru in 1929.

**The growth of U.S. influence.** The War of the Pacific left Peru deeply in debt. Nicolás de Piérola, who was president during the war, took over again as president in 1895. He and most of the presidents who followed him in office encouraged foreign investment to help develop the country's resources and reduce its debt.

The U.S. firm of W. R. Grace and Company already had sizable investments in Peru, including a textile mill and a number of sugar plantations and refineries. In 1901 and 1902, a group of U.S. businessmen formed the Cerro de Pasco Corporation to develop Peru's copper deposits. The International Petroleum Company, a branch of the Standard Oil Company (now called Exxon Corporation), gained control of the oil deposits in northwestern Peru in 1921.

Peru's economy improved in the early 1900's. But it worsened again under the presidency of Augusto Leguía in the 1920's. Leguía had been president from 1908 to 1912 and was reelected in 1919. He soon set himself up as a dictator. To finance his programmes, the government borrowed large sums of money from U.S. banks. Early in 1930, Peru felt the first effects of the economic depression that began in 1929. The armed forces, alarmed by Peru's rising debt, overthrew Leguía and made Colonel Luis Sánchez Cerro president.

**The rise of APRA.** Peru had a number of political parties before the 1920's. But most of them favoured the upper class. In 1924, Víctor Raúl Haya de la Torre founded a party called APRA, an abbreviation for Alianza Popular Revolucionaria Americana (American Popular Revolutionary Alliance). APRA called for public ownership of Peru's basic industries and demanded equal rights for all citizens, including Indians.

Haya de la Torre ran for president against Sánchez Cerro in 1931 and lost. APRA charged dishonesty in vote counting and staged violent antigovernment protests. The government then jailed or killed hundreds of APRA supporters. It also banned the party from fielding political candidates. But APRA continued to gain followers during the 1930's and early 1940's.

In 1945, President Manuel Prado ordered the first election since 1931 in which APRA candidates could take part. But APRA did not put up a presidential candidate of its own. Instead, it supported José Luis Bustamante, a respected lawyer and diplomat, who won the election. But quarrels with other political groups led APRA to further acts of violence after the election, and Bustamante outlawed the party in 1948. Later that year, military leaders overthrew Bustamante's government and named General Manuel Odría as president. For eight years, Odría worked to reduce APRA's influence. But he legalized the party before the 1956 election, the first in which Peruvian women voted. Manuel Prado, who had been president from 1939 to 1945, gained APRA's support and won the election.

In the 1950's and early 1960's, APRA lost popularity, while the Popular Action Party led by Fernando Belaúnde Terry gained support. Belaúnde was elected president in 1963 and worked to improve the Indians' living conditions. Belaúnde also gave them educational opportunities.

**Important dates in Peru**

**c. 900 B.C.** The civilization of the Chavin Indians, the first known civilization in Peru, reached its peak.

**c. A.D. 1500** The empire of the Inca Indians reached its greatest size.

**1532-1533** Spanish troops led by Francisco Pizarro conquered Peru and made it a Spanish colony.

**1780** The mestizo Tupac Amaru led an unsuccessful revolt of Indians and mestizos against white rule.

**1821** José de San Martín declared Peru independent of Spain.

**1879-1883** Peru lost its nitrate-rich southern provinces to Chile in the War of the Pacific.

**1924** The revolutionary APRA party was founded.

**1968** Military leaders took control of Peru's government and began socialist reforms.

**1980** A civilian government, elected by the people, began working to increase private enterprise.

**1992** In April, President Alberto Fujimori suspended Peru's Constitution and dissolved the legislature.

**1993** Peru adopted a new constitution. It was written by a popularly elected Constituent Assembly.

**Socialist reforms.** Peru began to have financial problems during the late 1960's. In August 1968, President Belaúnde reached a complicated financial agreement with the International Petroleum Company in return for the company's Peruvian oil fields. Belaúnde's opponents charged that the agreement favoured the company. In October, military leaders seized the government and formed a ruling *junta* (council). The junta named one of its members, General Juan Velasco Alvarado, as Peru's president.

The new government took over most of Peru's plantations and turned many of them into cooperatives. It also seized the holdings of International Petroleum, Cerro de Pasco, and W. R. Grace. In the early 1970's, the government began an industrial reform programme that gave workers partial control over some industries.

**Recent developments.** By the mid-1970's, the government faced growing criticism. Inflation and unemployment were rising. In 1975, General Francisco Morales Bermúdez replaced Velasco Alvarado as president.

In 1980, the people elected a civilian government to replace the junta. Belaúnde was again elected Peru's president. His government took some steps to increase private enterprise. Since 1980, a leftist group called Shining Path has sought to overthrow Peru's government using guerrilla tactics. Much fighting has taken place between Shining Path and government forces.

In 1985, Alan García Pérez of APRA was elected president of Peru. In 1990, Alberto Fujimori, an independent candidate, was elected president. Both men took steps to increase private enterprise. In another effort to improve the economy, García limited repayment of Peru's foreign debt. Fujimori reinstated payment of the debt. But economic problems and violence continued.

In April 1992, Fujimori suspended Peru's Constitution and dissolved the legislature. Fujimori claimed there was corruption among government officials. He accused officials of failing to pass reforms to eliminate Shining Path and the drug trade. Many Peruvians supported Fujimori. Others denounced him as a dictator. In September, police arrested Abimael Guzmán Reynoso, the leader of Shining Path. In October 1992, he and 10 other leaders of the group were convicted of high treason for terrorist crimes and sentenced to life in prison.

In November 1992, popular elections were held to form a Constituent Assembly. Supporters of Fujimori won a majority of the seats. The Assembly wrote a new constitution that was approved in December 1993. New presidential elections were scheduled for 1995. Fujimori and the Assembly were to continue to serve until then.

**Related articles** in *World Book* include:

**Biographies**

Atahualpa
Bolívar, Simón
Castilla, Ramón
Pérez de Cuéllar, Javier
Pizarro, Francisco
San Martín, José de

**Cities**

Arequipa
Callao
Cusco
Lima

**History**

Inca
Indian, American
Machu Picchu
Mummy (picture)
Sculpture (American Indian; pictures)

**Physical features**

Amazon River
Andes Mountains
El Misti
Lake Titicaca
Peru Current
Purus River

**Other related articles**

Alpaca
Clothing (picture: Traditional costumes)
El Niño
Guano
Latin America
Llama
Vicuña

**Outline**

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**VI. History**

**Questions**

Who developed the first known civilization in Peru?
What is the chief occupation in Peru?
What is a *mestizo*?
Why does the Peruvian coast receive so little rainfall?
What was the War of the Pacific? How did it affect Peru?
In what kinds of activities have Peru's armed forces traditionally been involved?
What role did Francisco Pizarro play in Peru's history?
How does the way of life differ among Peru's ethnic groups?
What are *pueblos jovenes*?

**Peru Current** is a cold, broad, yet shallow ocean current in the Pacific Ocean. It flows slowly northward along the west coast of South America. Along the coast of Peru, the temperature of its waters is 8° C colder than is normal for the surface of the Pacific in that latitude. Most scientists believe that winds blow the warm surface waters away, causing cooler waters from below to rise to the surface. This current is also called the *Humboldt Current* (see **Humboldt, Baron von**).

**Perutz, Max Ferdinand** (1914- ), an Austrian-born, British molecular biologist, shared the Nobel Prize for chemistry in 1962 with John Kendrew. Through X-ray techniques, they traced the structure of haemoglobin and myoglobin, two proteins found in blood and muscles. Born in Vienna, he fled to England in 1936 to escape Nazism. His essays were collected in *Is Science Necessary?* (1989).

**Pescadores** (pop. 100,288) is a group of 63 islands which cover a total area of 127 square kilometres in the Taiwan Strait between Taiwan and China. The Taiwanese name for the islands is *P'eng-hu*. For location, see **Taiwan** (map). A Chinese expedition discovered the islands in 1367. The islands were named *Pescadores* (fishermen's islands) in the 1500's by Portuguese sailors. They were occupied by the Dutch from 1622 to 1624, when China regained them. In the late 1600's, the Pescadores became a dependency of Taiwan. Industries on the islands include fishing and fish processing.

**Peseta** is the monetary unit of Spain and the Spanish dependencies, and of Andorra, a small country that lies between Spain and France in the Pyrenees mountains. It consists of 100 centimos. The early silver one-peseta piece showed the king's head and the Spanish coat of arms. Later coins showed such objects as a sheaf of wheat or a *galleon* (large sailing ship). Silver coins have been issued in the value of one, two, and five pesetas. The peseta was issued in brass in 1937, and later in aluminium-bronze. For the value of the peseta, see **Money** (table: Exchange rates).


**The peseta is the monetary unit of Spain.**

**Peshkov, Alexy Maximovich.** See **Gorki, Maxim.**

**Pest control.** See **Pesticide; Agriculture** (Pest control); **Fumigation; Insect** (Insect control); **Insecticide.**

**Pestalozzi, Johann Heinrich** (1746-1827), was a Swiss teacher who became a pioneer of modern education. Many of his ideas were new and startling for his time but have been absorbed into present-day educational practices and theory.

Pestalozzi was one of the first teachers to base his ideas on child psychology. He adjusted his teaching methods to children's stages of development. In all his theories, he stressed the dignity and worth of each person. He believed the purpose of education is to ensure the full development of each student's unique abilities. He thought education should aim for the intellectual, physical, and moral development of the individual.

Pestalozzi's teaching methods were revolutionary for his time. For example, he felt children could learn best in an atmosphere of love and freedom rather than by harsh discipline. Therefore, a child's education should begin in a warm and loving family. He also taught children to use their senses and to learn from doing rather than simply memorizing facts.

Many of Pestalozzi's educational theories were based on what he called *Anschauung*, a German word that means *perception* or *observation*. He felt that observation of objects, other people, and moral situations is the basis of all true knowledge. He believed children progress from an understanding of simple objects to a comprehension of difficult philosophical concepts.

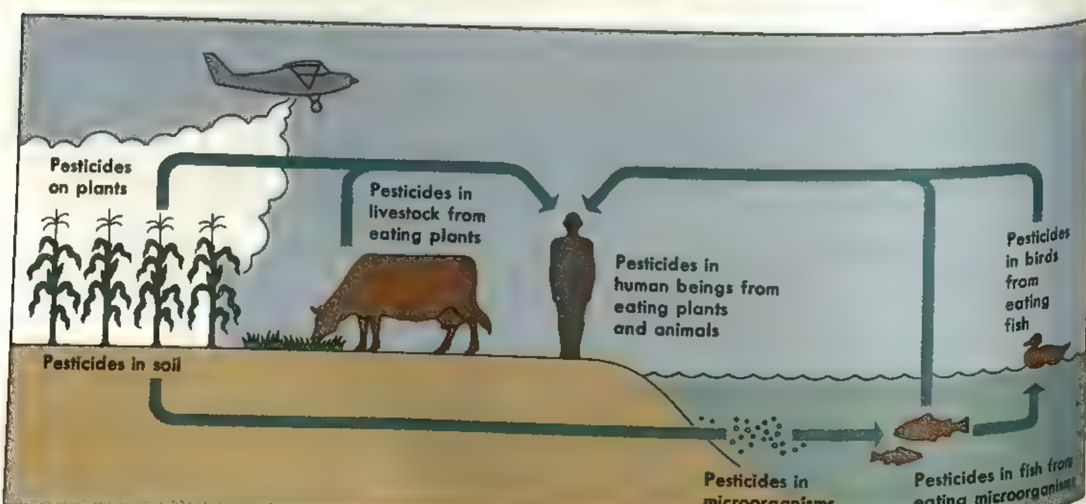
Pestalozzi left a lasting impact on education. His emphasis on the importance of understanding children helped establish the need for careful teacher training.

Pestalozzi was born in Zurich, Switzerland. He attended the University of Zurich, where he first studied for the ministry and later changed to law. He abandoned both careers and took up farming. In 1774, he turned his farm into a school for poor children, where he developed many of his educational ideas. In 1798, the Swiss government appointed Pestalozzi to head an orphanage at Stans, near Lucerne. During the early 1800's, Pestalozzi founded schools in Burgdorf and Yverdon. His work at these schools brought him international recognition. Teachers from many other countries came to study his methods. Many of them formed teacher institutes based on Pestalozzi's ideas. His major theories are presented in his books *Leonard and Gertrude* (1781-1787) and *How Gertrude Teaches Her Children* (1801).

**Pesticide** is a chemical used to control or eliminate pests. Insects are probably the major pests. Many kinds of insects transmit serious diseases, such as malaria and typhus. Some insects destroy or cause heavy damage to

**How pesticides move through a food chain**

Most pesticides last only long enough to control the target pest. But *persistent pesticides* remain in the environment long after that and can be absorbed by other organisms. The diagram below shows how human beings may absorb persistent pesticides from plants and animals that they eat.



valuable crops, such as maize and cotton. Other common pests include bacteria, fungi, rats, and weeds. Pests can seriously decrease the production of crops and livestock. Manufacturers use various chemicals in making pesticides.

**Types of pesticides.** Pesticides are classified according to the pests they control. The four most widely used types of pesticides are (1) insecticides, (2) herbicides, (3) fungicides, and (4) rodenticides.

***Insecticides.*** Farmers use insecticides to protect their crops from insect damage. In urban areas, public health officials use these chemicals to fight mosquitoes and other insects. Insecticides are used in homes and other buildings to control such pests as ants, flies, moths, cockroaches, and termites.

***Herbicides*** control weeds or eliminate plants that grow where they are not wanted. Farmers use herbicides to reduce weeds among their crops. Herbicides are also used to control weeds on railway tracks and in such public and recreational areas as parks, lakes, and ponds. People use herbicides in their gardens to get rid of dandelions and other weeds.

***Fungicides.*** Certain fungi are *pathogenic* (disease causing) and may infect both plants and animals, including human beings. Fungicides are used to control plant diseases that infect such food crops as apples and peanuts. Most disinfectants used in homes, hospitals, and restaurants contain fungicides.

***Rodenticides*** are used chiefly in urban areas where rats and other rodents are a major health problem. Rats carry bacteria that cause such diseases as rabies, ratbite fever, tularaemia, and typhus fever. Rats also destroy large amounts of food and grain, and rodenticides help protect areas where these products are stored.

***Other pesticides*** help control a variety of organisms. These pests include bacteria, mites and ticks, viruses, and roundworms called *nematodes.*

**Pesticides and the environment.** Pesticides differ according to their effects on various organisms. *Selective pesticides* are toxic only to the target pests. They cause little or no harm to other organisms. However, *nonselective pesticides* can harm—or even kill—organisms that are not considered pests. Nonselective pesticides should be used only when no other method of control is available.

Most pesticides last only long enough to control the target pest. But some are *persistent* (long lasting) and remain in the environment long after that. The possible effects of persistent pesticides can be traced by means of a process called *biological concentration.* This process shows how living organisms retain a chemical deposit through a biological cycle known as a *food chain* (see Ecology).

A pesticide is absorbed by organisms in a lower level of a food chain. Organisms in a higher level of the chain then eat many of the lower organisms and retain the chemical. This process continues until the highest organism in the chain retains the chemical. The amount of contamination in the highest organism is much greater than that in the lower organisms. The best-known case of biological concentration involved an insecticide called DDT. Many governments have now banned the use of DDT completely or else placed severe restrictions on its use (see **DDT**).

Some pests, such as cotton bollworms, mosquitoes, and rats, have developed increasing resistance to pesticides. New methods are being developed to control them. These methods, known as *integrated pest control systems,* combine the use of chemical pesticides with other effective techniques. For example, some farmers use *pheromones* to control certain insect pests. Pheromones are chemical scents released by animals as a form of communication. When the sex-attractant pheromones of harmful insects are sprayed into the air, the insects become confused and cannot find members of their species with which to mate. Pheromones may also be used to lure insects into traps.

See also **Fungicide; Insecticide; Plant** (Plant enemies); **Weed; Carson, Rachel.**

**Pet** is an animal kept for companionship and treated with affection. Animals have been kept as pets by people in all parts of the world for thousands of years. The most common pets are dogs, cats, budgerigars, hamsters, and fish. But many people keep unusual pets, such as lizards, snakes, insects, and monkeys. Many Japanese children tame mice and teach them to dance to music. Explorers in Antarctica have treated penguins as pets. The people of India make pets of mongooses. Cormorants are common pets in China.

Pets can make interesting, playful companions. People enjoy teaching them to do tricks and to obey commands. By caring for pets, children learn responsibility. They must see that their pets have food, exercise, and a proper place to live, so that they will be happy and healthy. In addition to providing companionship, many pets are useful. Dogs hunt, guard property, herd cattle and sheep, and lead the blind. Cats catch mice and rats. Canaries fill the air with happy, pleasing songs.

## Kinds of pets

**Pets for the home.** The kind of home you live in, and where you live have much to do with the kind of pet you choose. Dogs, cats, birds, and fish are easy to care for in almost any kind of home.

Before choosing a dog as a pet, you should consider the size of both your home and the dog. For example, a collie needs a large home with a big yard or garden for exercise. If you live in a flat, you should be sure pets are allowed. Then choose a small dog, such as a cocker spaniel. A small dog can get most of its exercise by playing around the house, and needs only short walks outside for fresh air.

Cats do not depend on their masters as much as dogs do. Many people prefer them for this reason. They are quieter and gentler than dogs. But they, too, need outdoor exercise. On pleasant days, a cat can run around in a garden. A cat should always be brought inside at night.

Various kinds of birds make good pets for a small home. They live in cages that take little space, and their singing, beauty, and antics will please you by the hour. Canaries sing songs, and their pert, happy ways make them pleasing pets. Finches also have musical voices. Their bright colours and active ways are fun to watch. The budgerigar is one of the most popular birds. It can learn to talk and is a great clown. A budgerigar can be trained to walk a tightrope, go through a tunnel, push and pull toys, and ride in toy cars or trains.

**Pets depend on their owner for food and shelter.** Dogs and cats eagerly await feeding time, *above.* Many children learn responsibility by caring for pets.

Fish have one advantage over most other pets. They can be left alone for a day or two without being fed. Most fish need food only a few times a week. You can make what is often called a *balanced aquarium* by growing plants in the fish tank. The plants supply some oxygen for the fish. The water does not need to be changed, but occasionally more water must be added to replace that which evaporates. Some kinds of tropical fish need extra care, such as controlled temperature, special foods, or oxygen bubbled through the water (see **Aquarium**).

Other small animals, including white mice, guinea pigs, and hamsters may be kept as pets in the home.

**Farm pets.** Farm children usually have many kinds of pets. Almost every farm has one or more dogs, and cats to keep down the mice. The children also play with and care for the baby animals that live on the farm. They may make pets of lambs, rabbits, kids, and even pigs. Baby chickens and ducklings often follow children around the yard, hoping for food. The children may have a pony, or a gentle horse to ride. Many farm boys and girls raise calves to show at county fairs. They brush their calves to keep them clean and sleek. They also make sure that the animals have clean straw for their beds.

**Pets in school.** Many school classes keep animals in the classroom as pets. Boys and girls learn how these animals eat, sleep, play, and take care of their young. They build houses or cages for their pets, and feed and care for them. Rabbits, guinea pigs, hamsters, mice, rats, fish, frogs, toads, and snakes are among the favourite school classroom pets. Sometimes classes keep ant colonies behind glass or keep beehives. Then they can watch the activities of a whole group of insects.

### Choosing a pet

Before buying a pet, learn as much as possible about all kinds of pets. Choose an animal that can live comfortably in the amount of space you have for it. Find out whether the pet needs outdoor exercise and, if so, how often. Will the pet need care during the day and will someone be at home to take care of it? How does the animal behave? Is it always friendly with strangers, or is it usually quiet? Does it like young children, or does it become easily upset and cross? What foods does it eat, and how much do these foods cost?

**An aquarium** of pet fish can be kept in almost any home, even a small flat. Fish, unlike most kinds of pets, do not have to be fed every day.

**Most farm children keep a variety of animals as pets.** Some farm pets, such as horses, *above,* are also used on the farm for work.

The only way to be certain what a pet will look like when it grows up, and how it will behave as an adult, is to buy a *purebred* animal. This is an animal whose parents were both of the same breed. But *mongrels,* or animals of mixed breeds, also make good pets. You should buy your pet from someone who has raised that kind of animal for a long time, or from a well-kept pet shop. Then you can be sure that the animal has had good care, proper food, and all the necessary vaccinations against disease. You can expect your pet to enjoy a long, healthy, happy life, if it has been properly cared for when young.

## Training your pet

Before you start to train any kind of pet, you must have its respect and affection. You must always treat it fairly. For example, the first time your dog jumps up at you, make it get down. If you let your dog jump on you when its paws are dry and clean, it probably will do so when they are wet and dirty. The dog does not know when it should not jump on you, and so you should not let it form the habit. Say firmly, "No, no" or, "Get down" as you put your pet down. Do this every time, until the dog learns not to jump on you.

Always speak gently to your pet, and try not to make quick, unfamiliar movements. This does not mean you cannot scold your pet. If the animal misbehaves, scold it at once. Use simple words, such as *no, no* or *naughty,* and say them so that the pet knows you are unhappy with it. Do not shout or speak angrily. The pet will not remember for long why it is being scolded, so make the scolding short. Of course, this kind of training is useless for such pets as fish and turtles.

**House training.** You should make preparations for house training a puppy or kitten even before bringing it home. For example, you can make a bed for a puppy by building a stout box with a lid and air holes. The puppy will be discouraged from using the box as a toilet if you make it only large enough for the pet to lie down and gnaw a bone. A dog instinctively wants to keep its bed clean. The animal cannot get out of the box by itself, and so it will make noise to let you know its need.

Bring the puppy home in the morning, so it can take several naps in the box that day. Meanwhile, select a place outdoors that you want your pet to use as a toilet. After you clean up the puppy's first body wastes, take them to the outdoor place and bring the animal there. The smell of its wastes will let the puppy know where to relieve itself. When your puppy uses the right place, praise the pet and take it back into the house. The puppy should spend the night in the box and should not be given food or water after 6 p.m.

A puppy needs to be taken out several times a day: (1) when it awakens in the morning, (2) after naps, (3) after feeding, and (4) before play. Any kind of excitement makes a puppy want to relieve itself.

A puppy should not be housebroken indoors on paper. You might not be able to retrain it to relieve itself at an outdoor spot. You should not let the puppy get you up in the middle of the night. Nor should you allow rain or snow to stop you from taking your pet out. Always take the puppy to its spot during the housebreaking period. Do not just put it outside. After about three days, the puppy will probably not make any mistakes.

**White mice** make excellent classroom pets. By studying such pets, students gain direct knowledge of animal behaviour. They also learn how to take care of the pets.

**Small birds,** such as the budgerigar shown above, make fine indoor pets. Normally, these birds must be kept caged. But by patient training, this owner taught her pet to sit on her hand.

To train a kitten, buy a cat tray and *litter* (artificial sand) at a pet store. Or you can use a box with clean sand. Place the tray near the kitten's food dish, and put the animal into the tray a number of times. A cat instinctively buries its body wastes, and so it will use the tray immediately. You should sift the wastes from the litter daily and change the litter weekly.

**Tricks.** To teach an animal a trick, you must first make it understand what you want it to do. To teach a dog to sit, for example, push it down to a sitting position. As you do this, say the word *sit.* Praise your pet when it sits correctly. Soon you will find that whenever you say, "Sit," the dog will sit. To make it sit up, raise its front feet as you say, "Sit up." A dog can learn many commands, and such tricks as to fetch, to roll over, to beg, to "say prayers," and to "play dead."

Dogs tire quickly as you train them. You should not work with them for more than 15 minutes at a time, and perhaps only once or twice a day. Stop at once if the dog is not paying attention, or if something else seems more interesting to it. You must have the dog's attention, and it must complete each command. Never allow your pet to perform a trick only halfway. And never become impatient when you try to teach it tricks.

Reward a dog with a pat on the head and a few words of praise when it has performed its lesson correctly. If you want to give the animal a special treat, feed it a dog biscuit or a piece of dog chocolate to exercise its teeth and gums. These treats can be bought from pet shops. Ordinary cake, biscuits, and sweets are bad for a dog and should never be given to the pet.

A cat can be taught to do simple tricks, such as jumping in the air for a ball, leaping over a stick, or walking on its hind legs. You must be patient and gentle to interest the cat in the trick and gain its confidence. Cats should be rewarded with a piece of meat when they perform well. Budgerigars usually learn tricks themselves when you put a ladder or toy car in their cages. Fish can learn to come to the side of the tank to receive their food, if you tap gently on the tank each time you feed them.

**For work.** Most kinds of dogs can be trained to do certain types of work. Dogs can retrieve, or bring back, game for hunters. They can help herd livestock, pull carts or sledges, and perform many other tasks. Careful training will bring the dog to perfect responses. For example, start training retrievers when they are about six months old. To teach a puppy to return an object you have thrown, give a command such as *fetch* as you throw the object. As the dog learns to return the object, throw it farther and farther away. Training in retrieving from the water starts by throwing an object a short distance into the water. Increase the distance until the dog retrieves the object perfectly.

Cats often keep homes and barns free from mice and rats. Pets such as frogs and toads help keep gardens free from certain kinds of insects.

### Taking care of pets

**Feeding.** The first rule for feeding any pet is to keep its dishes clean. Wash them thoroughly every day. Never overfeed your pet. The animal should always have enough exercise and look sleek and slim. Give a dog only as much food as it will eat without leaving any food in the dish. If it leaves the dish before emptying it, take it away. Feed your pet less the next time. Feeding a dog the right food at regular times helps protect it against sickness.

A balanced diet is necessary if your pet is to be healthy. You can buy prepared food for most kinds of pets. Scientists plan these foods so that they contain the right amounts of vitamins, minerals, and proteins for each type of animal. By using these foods, you can be sure that your pet receives the right nourishment. Prepared foods usually do not need anything added to them. But you may want to give your pet a treat, such as a little meat for the dog or cat, or a piece of apple or some greens for the budgerigar. Feed your pet at regular times, and be sure that it always has plenty of fresh water.

**Housing.** All pets must have good houses. Birds should live in cages suitable for their size and activity. For smaller birds, the cage bars should be close enough together so that the bird cannot push its head between the bars and strangle itself. The perches should be about 1.3 centimetres in diameter for canaries and budgerigars, and 2.5 centimetres in diameter for mynahs. Canaries, and other flying birds should have room to fly inside the cage. Put their perches at the ends of the cage. Hopping birds, such as finches and mynahs, should have the perches nearer to the bottom of the cage and closer together.

A dog or cat should have a warm, dry place for its bed. A basket, box, or pet bed will keep the pet off the floor and protect it from draughts. A dog living outdoors must have a house that is free from draughts. The door of the house should face away from the wind. It should be covered or sheltered against rain and snow. The house should be just large enough for the animal to stand up and turn around. A house that is too large will be cold.

**Cleanliness.** Most pets keep themselves clean. Cats sit for hours washing themselves. Birds preen themselves, or clean their feathers with their beaks. Canaries and mynahs enjoy hopping in water and splashing around. Budgerigars like to roll on wet lettuce leaves or to be sprayed with water from an atomizer.

Dogs and cats should not be bathed too often. Bathing removes the natural oils from their hair and skin. This makes them itch and scratch, and soon they may have open sores. They usually need baths only when they become very dirty. If your dog or cat becomes muddy, wipe off the loose mud, let its coat dry, then brush its coat well.

**Treating illness.** Most pets will enjoy good health with proper food, housing, and grooming. If one should be hurt, swallow something harmful, or otherwise become ill, it should be taken to a *veterinary surgeon,* or animal doctor.

Don't try to treat your pet's illness yourself, unless you know exactly what is wrong and what to do for it. Home treatment may seriously delay finding out what is wrong, and may even harm the animal.

**Preventing illness.** Most pet illnesses can be prevented. A veterinary surgeon can vaccinate a puppy to protect it from such fatal diseases as distemper, infectious canine hepatitis, leptospirosis, and rabies. A kitten may be vaccinated against cat distemper, also called *panleucopenia,* a deadly cat disease. Vaccination should begin when the pet is taken from its mother's milk and should continue throughout its life.

A sick animal can infect other animals. By keeping your pet at home, you can lessen its chances of getting sick. A puppy should be kept in the home and garden. If you take it elsewhere, you should keep it on a leash and avoid areas where other dogs—or rats—may be found. An infected dog or rat can spread leptospirosis through its urine.

Tiny parasites, such as fleas, mites, and ticks, may transmit disease germs from a sick animal to a healthy one. Pet stores sell flea collars, powders, and soaps that can rid your pet of these pests.

**Birth control.** Every year, animal shelters destroy millions of homeless cats and dogs. Therefore, you should not allow your pet to have babies unless you can be sure they will have a good home.

Veterinary surgeons can prevent an animal from having or fathering babies by *neutering* it—that is, by removing some of its sex organs. This operation is called *spaying* when performed on a female and *castration* when done on a male.

Neutering a pet may also eliminate some kinds of undesirable behaviour. For example, castrating a cat before it has had sexual experience can prevent it from chasing females and fighting. But a cat or dog should not be castrated before the age of 6 months, or it may become fat and lazy. A female kitten may be spayed when about 5 months old. A female dog should be spayed three months after its first period of *heat* (sexual excitement). See also **Cat** (Birth control); **Dog** (Social and moral responsibilities).

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**Pétain, Henri Philippe** (1856-1951), became a national hero of France because of his military leadership in World War I. Yet he was tried and imprisoned for treason in his old age because of his collaboration with the Germans in World War II.

**Military hero.** Pétain was born at Cauchy-la-Tour. He was educated at the French military academy of Saint Cyr and served as an army officer. In 1916, during World War I, he commanded the French forces in the heroic defence of Verdun (see **Verdun, Battles of**). Here he spoke his famous words "They shall not pass." In April 1917, Pétain was made chief of staff. He became commander in chief on the western front in May 1917, and remained in that post until March 1918. Pétain was made a Marshal of France in 1918.

**Political career.** Pétain served briefly as minister of war in 1934. His critics accused him of secret hostility to the French Republic and also of sympathy for the dictatorial government of Francisco Franco in Spain. He served as ambassador to Spain in 1939 and 1940. Pétain was called home to be vice premier of France in the desperate World War II days of May 1940, when France was unable to stop the German invasion. On June 16, 1940, at the age of 84, Pétain became premier. Against the objections of some of his colleagues, he arranged the armistice with Germany.

Henri Philippe Pétain

**Collaborator.** Pétain became "chief of state" in the French government when its capital moved to Vichy. He accepted collaboration with Germany as an inescapable necessity. Petain's government undertook measures against Jews, paid heavy financial tribute to the Germans, and sent large numbers of French workers to Germany.

The Germans overran all of France in 1942, and Pétain became powerless. After the Allied troops landed in France in June 1944, the Germans took him to Baden, where he remained until after the war.

In 1945, Pétain was returned to France. He was tried for treason and was convicted. Pétain died in prison at the age of 95.

See also **France** (picture: Henri Philippe Pétain).

**Petal.** See **Flower** (The corolla).

**Peter I** (1844-1921), a Serbian king, ruled from 1903 to 1921. After the death of his father, Prince Alexander, Peter became head of the Karageorgevic dynasty. He became king when the king of Serbia, also named Alexander, was assassinated. Upon assuming the throne, Peter sought help from Russia in acquiring the province of Bosnia. This province, ruled by Austria, was the home of many Slavs. Russia's support of Peter, together with the assassination of Archduke Francis Ferdinand of Austria by Serbs, helped produce World War I. After the war, Serbia and Bosnia became part of Yugoslavia. Peter re-

Oil painting on canvas (early 1700's) by Louis Caravaque

**Peter the Great** was a powerful ruler who succeeded in bringing western European culture and customs to Russia.

tired from the throne in 1914, and his son Alexander served as regent. Peter was born in Belgrade, in Serbia. As a boy, he and his family lived in exile, and Peter was educated in Hungary and France.

**Peter I, the Great** (1672-1725), a Russian ruler, is famous for having gained access to the sea for Russia and for "westernizing" Russian customs and institutions. He made Russia a great world power.

**Early life.** Peter was born in Moscow. He came to the throne at the age of 10, together with his weak-minded half brother Ivan V (1666-1696). His half sister Sophia seized the regency, but Peter's followers deposed her in 1689 and he assumed supreme power.

Through contacts with foreign artisans, soldiers, and merchants who lived in Moscow, Peter acquired an interest in western civilization. In 1697, he decided to extend his knowledge of the West, and sent a delegation on a tour through Germany, the Netherlands, England, and Austria. He included himself as a member. He used this famous trip not only for political negotiations, but also for studying military techniques, shipbuilding, and other western crafts, and for learning western habits.

A revolt by his royal guards forced Peter to return to Russia in 1698. He brutally suppressed the revolt and crushed all opposition, especially that of the nobility. This victory made Peter the unchallenged master of Russia. He then began his vast reform work.

**Foreign policy.** Peter's first aims were to secure for Russia the rank of a great power and to gain access to the sea. To achieve the second purpose, he declared war on Turkey. He conquered the Turkish port of Azov on the Black Sea but later was forced to return it. Next, Peter engaged in a 20-year war with Sweden. After a bitter defeat at Narva in 1700 and a great victory at Poltava in 1709, he gained possession of most of Livonia and part of Finland, including the great ports of Riga, Reval, and Viborg on the Baltic Sea. Finally, he turned his attention eastward and made war on Persia (now Iran), from which he acquired two ports on the Caspian Sea. He also ordered that trips of discovery be made along the northern coast of Siberia, and he concluded trade negotiations with China.

**Policies within Russia.** Peter strengthened his absolute power, and forcibly introduced western habits. He demanded state service from all his nobility and abolished the old council of the nobility. He replaced it with a senate and various colleges, or ministries. He chose people of ability for high military and administrative offices, rather than merely hereditary nobles.

Peter extended peasant serfdom, forced the serfs into industrial work, and harshly suppressed their rebellions (see **Serf**). He abolished the highest church office, the patriarchate, and introduced a system to control the church. He took land away from the monasteries and extended toleration to religious dissenters.

Peter paid careful attention to improving the Russian army and he also built a Russian navy. He introduced new industries, modernized mining in the Ural Mountains, built roads and canals, and improved the status of Russian merchants. He invited experts from other countries to direct new enterprises. To finance his reforms, he imposed high taxes and reserved profitable business monopolies for himself.

Peter founded schools and laid the basis for the Russian Academy of Sciences. He ordered children of the nobility to study abroad, encouraged the adoption of European manners, and called in foreign professors and scientists. He urged Russian women to take part in social life. He ordered the men to shave (the church favoured beards) and to shorten their customary long coats. He founded the capital city of St. Petersburg as his "window to the West."

**Lasting achievements.** Peter truly transformed Russia, giving it a vigorous start on the path of modernization. But the haste with which he pushed reforms sometimes hindered progess. He brutally overrode all opposition. When his son Alexis opposed his reform work, Peter had him executed. He also drove his first wife from him when she opposed his reforms. Nevertheless, his work had lasting influence.

See also **Catherine (I); Romanov; Russia** (History); **Saint Petersburg.**

**Peter II** (1923-1970) became king of Yugoslavia in 1934 at the age of 11 when his father, King Alexander, was assassinated. See **Yugoslavia.** During his childhood, Peter's cousin Prince Paul served as regent. Peter took the throne in 1941. During World War II, the German army invaded Yugoslavia and Peter set up an exile government in London. He never returned to his country. Communist partisans gained control of Yugoslavia during the war, and in 1945 the monarchy was abolished. Peter was born in Belgrade in what is now Serbia.

See also **Alexander I.**

**Peter, Epistles of,** are the 21st and 22nd books of the New Testament of the Bible. They are letters from the apostle Peter. Most scholars doubt that Peter actually wrote the letters. They believe the letters were written in his name by someone else. The first Epistle was probably written between A.D. 81 and 96 or 98 and 117, during a persecution of the church by the Roman Empire. The letter's main purpose is to encourage perseverance in Christian faith despite suffering. The second Epistle may have been written as late as A.D. 130 or 140. It is proba-

bly the last book of the New Testament to be composed. Its main purpose is to argue that Jesus Christ will some day return, despite doubts that had arisen concerning His Second Coming.

**Peter, Saint** (?-A.D. 64?), was a leading apostle of Jesus Christ. He was a leader of the early Christian community in Jerusalem and is a prominent figure in the New Testament of the Bible. Peter's original name was Simon. Jesus gave him the name Peter, which means *rock* in Greek. Peter is sometimes called Simon Peter in the New Testament.

In a passage from the New Testament, Jesus is portrayed as saying to Peter:

"And I say unto thee, That thou art Peter, and upon this rock I will build my church; and the gates of hell shall not prevail against it. And I will give unto thee the keys of the kingdom of heaven: and whatsoever thou shalt bind on earth shall be bound in heaven: and whatsoever thou shalt loose on earth shall be loosed in heaven." (Matt. 16: 18-19).

Traditionally, Roman Catholics regard the above passage as evidence that Jesus chose Peter to be the first head of His church. They believe He established the position of pope through Peter. Protestant scholars interpret the passage to mean that Jesus meant His church to be founded on Peter's faith in Him. However, both groups agree that Peter led the early Christian community.

**Early life.** Peter, a Jew by birth, was born in Bethsaida, a town in Palestine on the east bank of the Jordan River. The apostle Andrew was his brother, and the apostle Philip also came from Bethsaida. Peter later moved to the nearby town of Capernaum on the bank of the Sea of Galilee, where he became a fisherman. Stories in the New Testament portray Peter as a warm, generous, stubborn, and impulsive man. He was married and may have had children.

Peter and Andrew met Jesus while they were fishermen. One day, Jesus said to the brothers, "Follow me, and I will make you fishers of men" (Mark 1: 17). Peter and Andrew left their homes and joined Jesus on His travels.

**Life as an apostle.** Stories in the New Testament reflect Peter's importance in the Christian community as a close friend of Jesus and His followers. Peter, along with the apostles James and John, is said to have witnessed the Transfiguration (see **Transfiguration**). Jesus also talked with Peter about religious matters. When Jesus asked the apostles about His identity, Peter replied, "Thou art the Christ" (Mark 8: 29).

The Gospels suggest that Peter understood Jesus and His significance only after the Resurrection. Before the Crucifixion, Peter denied three times that he knew Jesus. Peter later wept in repentance (Mark 14: 72). Peter was one of the first witnesses of the Resurrection listed by Saint Paul (I Cor. 15: 5). After the Resurrection, Jesus appeared to Peter in a vision. This vision and the faith in Jesus that it produced is the foundation of Christianity.

After the Resurrection, Peter became an authority among the Jewish Christians in Jerusalem. He probably served as a peacemaker between conservative Aramaic-speaking Jews led by James and the more liberal Greek-speaking Jews led by Paul. Peter is sometimes called the "Apostle to the Jews."

**Later years.** Peter apparently left Jerusalem with his wife and became a wandering missionary. According to Christian tradition, Peter became the first bishop of Antioch in Syria, and the first bishop of Rome. He may have died a martyr in Rome during the persecution of Christians by the Emperor Nero from A.D. 64 to 68. According to Christian tradition, Peter was buried under what became the site of St. Peter's Church in Vatican City. There is no conclusive evidence for any event related to his death.

No undisputed writings by Peter have been preserved. Writings by Paul describe Peter as a source of oral stories about Jesus. The New Testament includes two essays called *Epistles of Peter*. The First Epistle, which urges a group of Christian converts to remain faithful in times of persecution, may have been written by Peter. However, the Second Epistle was written by an unknown author sometime during the 100's.

**Monuments** to Peter, in addition to stories about him, honour him as a missionary and an organizer of the Christian church. By the 100's, a shrine that many believed contained Peter's remains had been built in Rome. The shrine attracted many Christian pilgrims. Early Christians honoured Peter in art and literature, where he was called the Fisherman, the Rock, and the Shepherd.

By about 450, many Christians believed that the pope was the successor of Peter. They also believed Peter was a saint. June 29 is the feast day of Saint Peter.

See also **Jesus Christ; Michelangelo** (picture: *The Crucifixion of Saint Peter*); **Peter, Epistles of; Pope; Roman Catholic Church** (picture: The first pope).

**Peter Pan** is the boy hero in several fantasies written by the Scottish author Sir James Matthew Barrie. The

**A statue of Peter Pan** stands in Kensington Gardens, London. Sir James Barrie, the creator of Peter, commissioned the statue.

character first appeared in Barrie's novel *The Little White Bird* (1902). Barrie adapted part of the novel into the play *Peter Pan* (1904). Several chapters of the novel were published in 1906 as *Peter Pan in Kensington Gardens.* Barrie also wrote the novel *Peter Pan and Wendy* (1911). See **Barrie, Sir James Matthew.**

The play *Peter Pan* provides the best-known version of the boy's adventures. In the play, Peter Pan has run away to Never-Never Land to escape growing up. One night, he returns to the human world and meets the three Darling children—Wendy, John, and Michael. Peter persuades them to fly with him and the fairy Tinker Bell back to Never-Never Land. There they have many adventures. Other characters include a crocodile, the Indian princess Tiger Lily, and the evil Captain Hook.

**Peter Rabbit.** See **Potter, Beatrix.**

**Peter the Hermit** (1050?-1115?) was a French monk of Amiens who encouraged the First Crusade (see **Crusades**). In 1095, he began to preach the need for Christians to undertake a crusade to get back the Holy Land, which was then under Muslim control. Wearing a monk's rough cloak and a crucifix, Peter rode about France trying to inspire people to join him. In 1096, Peter led an undisciplined army drawn mainly from the poorer classes through Europe to Asia Minor. There most of his followers were killed by Turks. Peter and the survivors joined the forces of Godfrey of Bouillon and helped take Jerusalem.

**Peterborough** (pop. 148,800) is a local government district and city in Cambridgeshire, England. The city stands on the River Nene and is a prosperous agricultural and manufacturing centre. It has brickworks, electronics and engineering works, and beet-sugar refineries. Its cathedral is built in the Norman and Early English styles. Peterborough was designated a *new town* (area of rapid development) in 1967. Arable farming is important in the rural areas of the district. See also **New town; Cambridgeshire.**

**Peterlee.** See **Durham; New town.**

**Peterloo** was the name given to an incident in 1819, when social unrest in England was producing a wide demand for parliamentary reform. A mass meeting of 60,000 people gathered in St. Peter's Field, Manchester, to hear a speech by Henry (Orator) Hunt, a radical leader. Magistrates sent troops to arrest Hunt. When the crowds resisted, the troops charged with drawn sabres, killing 11 people and wounding about 400. The incident became known as the *Peterloo Massacre.*

**Petipa, Marius** (1818-1910), was a great French *choreographer* (dance composer). Petipa joined the ballet of the Imperial Theatre in St. Petersburg, Russia, in 1847. He was its head from 1862 to 1903. He composed 57 evening-long ballets and many shorter ones. The best-known include *Sleeping Beauty, Raymonda, La Bayadère,* and act three of *Swan Lake.*

Under Petipa's leadership, the Imperial Ballet of St. Petersburg became the finest in the world and its school produced such great dancers as Nijinsky, Pavlova, and Fokine. The St. Petersburg ballet is now known as the Kirov Ballet. See **Ballet** (History: Russian ballet).

Petipa was born in Marseille, France. He danced as a boy in the United States and became a star at 19. But a leg injury in Russia slowed down his career and turned him toward choreography.

**Petit, Roland** (1924- ), is a French dancer and *choreographer* (dance composer). He created a popular, theatrical dance style, breaking away from the formal conventions of French ballet.

Petit was born in Villemomble, France. After dancing with the ballet of the Paris Opéra from 1939 to 1944, he cofounded the Ballets des Champs-Elysées in 1945. From 1948 to 1959, he was artistic director of the Ballets de Paris de Roland Petit. He choreographed his best-known work, *Carmen* (1949), for the company. Since 1972, Petit has been artistic director of the Ballet National de Marseille. He has also choreographed films and stage revues.

**Petit basset griffon vendéen** is a short-legged, rough-coated dog bred to hunt small game, especially hare and rabbit. The name is sometimes abbreviated *PBGV.* The breed originated in Vendée, a region of rough terrain in western France. It is a *scent hound,* which means it hunts by following the scent of the game animal.

The PBGV stands about 33 to 38 centimetres high at the shoulder and weighs from 14 to 19 kilograms. Its rough coat is mostly white with orange or grey markings. Its ears are long and narrow and covered by long hair, and it has a moustache and beard. The PBGV is alert, intelligent, and lively and can make a good pet.

**Petit jury.** See **Jury.**

**Petit mal.** See **Epilepsy.**

**Petit point** is a delicate form of embroidery usually sewed on fine mesh canvas. The term is also used to describe the finished canvas. Petit point is sometimes called *tent stitch* or *half stitch.*

The term *petit point,* which is French, means *small stitch* and refers to the tiny size of the stitches. These stitches slant from left to right and are parallel to one another. The sewer uses a thin needle and fine thread.

Petit point is especially suitable for highly detailed designs on such small objects as spectacles cases, gloves, and handbags. The stitch is also used for embroidering larger canvas panels to decorate furniture seats and backs and canvas pieces that may be framed for display.


Detail of sampler (1794)

**Petit point** is a tiny stitch used in embroidery. In the example shown above, the church and fence are embroidered in petit point. A larger stitch was used for the surrounding area.

People have embroidered petit point since the Middle Ages, but the term did not appear until the 1700's in France, when the stitch became popular.

See also **Embroidery; Needlepoint.**

**Petitgrain oil** is a yellowish oil made from the leaves, twigs, and fruit of the bitter orange tree. It is used in many perfumes. Paraguay supplies about seven-tenths of the world's petitgrain oil. Petitgrain bigarade, an oil more valuable than petitgrain oil, is made from another variety of the bitter orange tree. Petitgrain bigarade is produced in Mediterranean countries.

See also **Orange** (Sour or Seville oranges).

**Petition** is a written document signed by a large number of people demanding some form of action. Petitions are generally presented to a local or national government. People organize petitions for a variety of purposes. For example, people may sign a petition opposing a road-widening scheme that would involve the demolition of many houses, or may use a petition to protest against the political actions of another country. The word *petition* once meant a formal or legal request. In some countries, such as the United States, written requests submitted to a court of law, a public official, or a legislative body are called petitions.

**Petition of Right** was a document written in 1628 by the English Parliament and presented to King Charles I. It declared unconstitutional certain actions of the king, such as levying taxes without the consent of Parliament, housing soldiers in private homes, setting up *martial law* (military government), and imprisoning citizens illegally.

Charles did not like the Petition of Right, but he accepted it because he knew of no other way to persuade Parliament to vote the funds he had demanded. But he did not intend to carry out his part of the agreement. He continued to rule without consent of Parliament until his unjust methods brought about his execution in 1649.

The Petition of Right had important results, even though it did not accomplish its immediate aims. It declared, in effect, the supremacy of law over the personal wishes of the king. It also rejected the *divine right of kings,* the belief that monarchs get their right to rule directly from God, rather than from the consent of their subjects. The petition is a landmark in the history of constitutional government in England.

See also **Charles (I)** of England.

**PETN** is short for *pentaerythritol tetranitrate,* an explosive more powerful than TNT. It is used as the core of detonating caps and fuses because it is capable of exploding in small devices. The combination of PETN and TNT is called *pentolite.* Doctors also use PETN in treating certain heart disorders.

**Petra** was an ancient city south of the Dead Sea in what is now Jordan. It was an important trading centre from the late 400's B.C. to the early A.D. 200's. The city stood on the overland trade route that linked Arabia and the Mediterranean Sea. The Nabataeans, a group of Arabian people, came to power in Petra in the 400's B.C. In A.D. 106, Roman forces conquered Petra and made it part of the Roman Empire. Petra prospered from A.D. 106 to the early 200's. The people built temples on the plain there, and they cut deeply into the cliffs to make houses. Petra had often been called the *rose-red city* because of its red stone buildings and the red cliffs surrounding it.

About A.D. 235, Petra suddenly stopped making coins, and Palmyra, a city in Syria, took over most of Petra's trade. Petra then became chiefly a religious centre. It became a Christian city by the A.D. 300's. Muslims captured the city in the 600's. The Franks, a Germanic tribe, occupied it during the Crusades, and held it until 1189. Soon after, the city was abandoned, and it fell into ruin (see **Jordan** [picture: The ruins of Petra]).

**Petrarch** (1304-1374) was a great Italian poet and scholar. His love poetry has had an unparalleled influence on world literature. He was also such a respected scholar that rulers and popes sought his services. Petrarch led in discovering the greatness of classical writers and helped start the movement later called *humanism.* Such Latin writers as Cicero and Livy might be almost unknown today if Petrarch had not found their lost works buried in monastery libraries.

In his own day, Petrarch's Latin writings were considered revivals of the Greek and Roman style of literature. His intimate knowledge of the classics led to his conviction that there is no essential conflict between classical and Christian thought. This conviction anticipated the spirit of the Renaissance.

Throughout his life, Petrarch composed poems of varying length in Italian to praise a beloved woman called Laura. Scholars are not certain that Laura really lived. At first, Petrarch saw in Laura a fleeting image of beauty which he never tired of describing. Eventually he added Christian dimensions to this image of beauty, reflecting implications of human hopes, aspirations, and duties.

Petrarch wrote more than 400 poems in Italian. Of these, 366 form his *Canzoniere* (*Book of Songs*), on which his reputation rests. Petrarch divided the collection into two parts. The first contains poems presumably written during Laura's lifetime and the second written after her death. In the first part, the reader senses a parallel between the poet's attempts to define Laura and Apollo's pursuit of Daphne in the famous classical myth (see **Daphne**). In the second part, however, Laura assumes the role of a guide, leading her lover toward God and toward ultimate salvation.

The *Canzoniere* includes a roughly chronological history of the poet's overwhelming passion for Laura and ends with a hymn to the Virgin Mary. The work expresses a haunting sense of the passage of time and of the vanity of earthly endeavours. It also shows an intense awareness of the conflict between spiritual and earthly values. The tone of the collection alternates bodily pleasure with spiritual love and religious feeling. The poems thus mirror an individual's uneasy condition as being capable of both the lowest depths and the greatest heights. Technically, Petrarch achieved new perfection in writing the sonnet and the ode, the chief literary forms in the *Canzoniere.*

Petrarch was born Francesco Petracco in Arezzo, Italy. He spent most of his productive years in France where his father was in political exile.

**Petrel** is one of a large group of ocean birds. They range over all the oceans of the world. Petrels seldom come near land except during the breeding season, or when they are blown ashore by storms. They usually nest on protected ledges or in burrows along the shore. Petrels are coloured black, grey, or white. They range

from about 15 to 90 centimetres long. Some petrels feed by diving into the water. But most petrels fly close above the waves and pick up food from the surface.

Small petrels are often called "Mother Carey's chickens" by sailors. They have a "walking flight" as they course over the water. They seem to be walking on top of the ocean.

There are many kinds of petrels. Scientists have divided them into three groups. One group includes the *shearwaters, fulmars,* and *petrels.* Another is made up of the *storm-petrels.* The third group is the *diving-petrels,* which live only in the Southern Hemisphere.

**Scientific classification.** Petrels make up three families of the order Procellariiformes. Shearwaters, fulmars, and petrels make up the family Procellariidae. Storm-petrels are *Hydrobatidae.* Diving-petrels are *Pelicanoididae.*

See also **Fulmar; Bird** (picture: Birds of the ocean and the Antarctic); **Cahow; Shearwater.**

**Petrie** is the name of a family of Australian pioneers.

**Andrew Petrie** (1798-1872), a builder and architect, was one of the first free settlers in Brisbane, Queensland, Australia. Born in Fife, Scotland, he landed in Sydney as a free worker in 1831. After working as a clerk in the ordnance department, Petrie became clerk of works at Moreton Bay (now Brisbane) in 1837. When the convict station was removed in 1839, Petrie stayed on as a free settler. He designed and built many of the important buildings in the settlement. His journeys contributed to the knowledge of the surrounding area. Petrie was the first person to climb Mount Beerwah, in the Glasshouse Mountains. He also brought back to Brisbane the first samples of the bunya pine. In 1842, he discovered the Mary River.

**Thomas Petrie** (1831-1910), Andrew's son, was particularly concerned with the Aborigines and their way of life. He was born in Edinburgh, Scotland, and arrived in Australia with his parents the same year. His interest in Aborigines started in childhood and developed throughout his life, and he became an authority on their languages and customs. Petrie's records of Aboriginal customs are extremely valuable because he developed an intimacy with the Aborigines before their association with other Europeans began to alter their way of life. His experiences were recorded in *Tom Petrie's Reminiscences of Early Queensland,* published in 1904. In 1877, he helped organize the first Aboriginal reserve at Bribie Island, Queensland.

**Petrie, Sir Flinders** (1853-1942), an English archaeologist, served as professor of Egyptology at University College, London, from 1892 to 1933. In 1894, he founded the British School of Archaeology in Egypt. Petrie showed an early interest in archaeological research, and investigated the ancient British remains at Stonehenge. In 1880, he began a series of surveys and excavations in Egypt that resulted in important discoveries. He founded the *Journal of Egyptian Archaeology* in 1911. Petrie wrote many works, including *Stonehenge* (1880), *Pyramids and Temples of Gizeh* (1883), *Ten Years' Digging in Egypt* (1892), *Egypt and Israel* (1911). He was born William Matthew Flinders Petrie in Charlton, Kent, and was privately educated.

**Petrie, George** (1789-1866), an Irish artist, antiquary, and musician, devoted much of his life to the study and recording of Irish antiquities. He published *The Petrie Collection of the Native Music of Ireland* in 1855. Petrie's *Essay on the Antiquities of Tara* (1837) won him a gold medal from the Royal Irish Academy. His *Essay on the Round Towers of Ireland* (1845) gave the first clear explanation of the origin and purpose of round towers.

Petrie was born and educated in Dublin. He achieved early recognition as an artist and later toured Ireland, studying its music and architecture.

**Petrified forest** is made up of tree trunks that were buried in mud, sand, or volcanic ash ages ago and have turned to stone. This action is caused by water that carries dissolved mineral matter. The water seeps through the mud and sand into the buried logs. There it fills the empty cells of the decaying wood with this matter until the structure has become solid stone. This stone shows many details of the original wood structure, especially under the microscope.

Petrified logs are buried in various rock formations from different geologic periods. These fossils represent the types of trees that grew during a certain period. Petrified forests have been found in many states of America, especially in the Western states and New York. There is also a petrified forest outside Cairo and two small examples at Lulworth Cove and Purbeck in southern England.

The most famous petrified forest lies near the town of Adamana, in northern Arizona, U.S.A. It covers about 100 square kilometres, which have been set aside as the Petrified Forest National Park. Thousands of petrified logs may be seen lying about on the surface where water has washed away the rock in which they were buried. On average, the logs measure about 1 metre across and between 18 and 38 metres long. Most of them have broken into many pieces and lie scattered about. Only a few logs are still whole and none of them stand upright. The logs were carried there by a flooded river perhaps around 225 million years ago. As they travelled down the river, they were stripped of their branches and leaves. Through the ages, many of the logs have become rainbow-coloured. Thousands of people have visited the park to see this scenic display.

In the original forests, the logs were the trunks of coniferous trees related to the Norfolk Island pine. Today they consist largely of quartz and opal, two forms of silica. Their yellow, red, purple, and black colorations were produced by impurities of the oxides of iron and manganese.

**Petrochemicals** are chemicals made from petroleum or natural gas. They are among the most important materials used in industry. Manufacturers use petrochemicals in making such products as detergents, fertilizer, medicines, paint, plastics, synthetic fibres, and synthetic rubber.

The basic materials of the chemical industry are the *primary petrochemicals.* They may be divided into three major groups, according to their chemical structure: (1) olefins, (2) aromatics, and (3) synthesis gas.

Important olefins include *ethylene, propylene,* and *butadiene.* Ethylene and propylene serve as important sources of industrial chemicals and plastics products. Butadiene is used in making synthetic rubber.

The chief aromatic petrochemicals include *benzene, toluene,* and *xylenes.* Benzene is used in the manufacture of dyes and synthetic detergents. Toluene is used in

making explosives. Manufacturers use xylenes in making plastics and synthetic fibres.

Synthesis gas is a mixture of carbon monoxide and hydrogen. The petrochemicals *ammonia* and *methanol* are made from synthesis gas. Ammonia is used in making fertilizer and explosives. Methanol serves as a source for other chemicals.

**How petrochemicals are made.** Petroleum and natural gas consist chiefly of compounds of the elements hydrogen and carbon. These compounds are called *hydrocarbons.* Most petrochemicals contain carbon that comes from such hydrocarbon compounds.

One important method of producing olefin and aromatic primary petrochemicals is a process called *steam cracking.* In this process, hydrocarbons separated from natural gas or crude oil are mixed with steam in a tubular furnace and quickly heated to between 800° and 900° C. The hydrocarbons are thus broken down to simpler compounds, which then combine to form the desired petrochemicals. Primary petrochemicals, especially aromatics, may also be produced as by-products of petroleum refining.

Complex petrochemicals are made by combining two or more primary petrochemicals. For example, ethylene and benzene can be combined to form *ethylbenzene,* used to make synthetic rubber. Other complex petrochemicals include *polyethylene, polypropylene,* and *polyvinyl chloride.* Manufacturers use these petrochemicals in producing such plastics goods as car parts, electrical insulation, leatherlike clothing and luggage, records, and squeeze bottles.

**History.** The first chemical to be made from petroleum or natural gas was produced from natural gas in the United States in 1872. This chemical, *carbon black,* is now used as a reinforcing material in tyres.

The widespread use of oil and gas to make chemicals began during the 1920's. At that time, coal was used as a source of many chemicals. However, chemical companies began using petroleum and natural gas to produce the same chemicals because oil and gas were cheaper and easier to obtain than coal. Petrochemicals enabled manufacturers to produce such materials as plastics and synthetic fibres as cheaply as possible. The use of petrochemicals increased rapidly during World War II (1939-1945). The armed forces used many products made from petrochemicals, including explosives and synthetic rubber.

During the 1970's and 1980's, the petrochemical industry required an increasingly large percentage of the oil and gas consumed throughout the world. At the same time, some scientists predicted that the world's supply of petroleum and natural gas would become scarce in the early 2000's. They believed that many countries would return to coal—or begin using shale—as a source of chemicals.

**Related articles** in *World Book* include:

| | | |
|---|---|---|
| Alcohol | Gas (Gas products) | Rubber |
| Ammonia | Hydrocarbon | Textile |
| Benzene | Methanol | Toluene |
| Carbon | Petroleum | Vinyl |
| Ethylene | Plastics | |

**Petrograd.** See **Saint Petersburg.**

**Petrol** is one of the most important fuels used for transportation. Most petrol is used in engines that move cars and trucks. Petrol engines also power such vehicles and machines as aeroplanes, motorboats, tractors, and lawn mowers. Petrol is sometimes called gasoline.

The widespread use of petrol began in the early 1900's, when the mass production of cars started. Petrol-powered cars enabled people to travel more easily. People no longer had to live near their jobs, and they could reach remote holiday spots more quickly. Petrol-powered farm machinery allowed for improved crop production.

Over the years, the increasing use of petrol gave rise to a gigantic industry employing millions of people. However, the use of petrol has also caused serious problems. For example, transporting petroleum and the manufacture and use of petrol contribute heavily to air and water pollution.

## How petrol is produced

Most petrol is made by separating and chemically changing the different compounds in petroleum. This process is called *refining.* For information on petroleum refining, see **Petroleum** (Refining petroleum).

Some petrol comes from the natural gas found with petroleum. Petrol manufacturers remove this *natural* or *casinghead* petrol from the natural gas. The refiners then blend the natural petrol with other petrol. Petrol can be made by many processes from anything containing the elements carbon and hydrogen. One of the most promising sources of petrol for the future involves processing the oil contained in shale rock. But refiners do not use this source yet because of its high cost.

## Petrol octane ratings

Petrol is a blend of hundreds of chemical compounds called *hydrocarbons.* Most of the mixture consists of about 25 compounds. Each hydrocarbon in petrol burns differently in an engine. See **Hydrocarbon.**

Petrol types are made with different combinations of hydrocarbons, because all engines cannot run smoothly on the same combination. Engines differ according to how much they *compress* (squeeze) the mixture of evaporated petrol and air in their cylinders. High-compression engines squeeze the fuel and air more than low-compression engines do. When an engine compresses the petrol and air, the temperature of the mixture rises. The rise in temperature may ignite the petrol before the piston is ready to receive the power from the burning petrol. This process is called *autoignition* or *preignition.* The petrol mixture may also explode suddenly before the spark plug fires. These actions waste power and can damage an engine. They cause a "knocking" or "pinging" sound. To operate smoothly, a high-compression engine needs a petrol more resistant to knocking than does a low-compression engine.

A petrol's ability to resist knocking is called its *antiknock* quality. The *octane number* of a petrol indicates the antiknock quality of the fuel. Engineers determine a petrol's octane number by comparing its resistance to knocking with the antiknock performance of a *reference fuel.* A reference fuel is a mixture of two hydrocarbons called *isooctane* and *normal heptane.*

A petrol's octane number equals the percentage of isooctane in a reference fuel that has the same antiknock quality as the petrol. For example, if a petrol knocks like

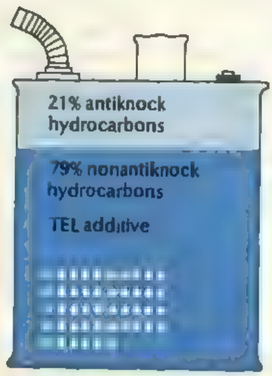
**Leaded and unleaded petrols**

Leaded petrol contains tetraethyl lead (TEL), an antiknock additive, to help the fuel burn smoothly. However, TEL contributes to air pollution. Petrol refiners developed unleaded petrol to eliminate the TEL needed for smooth burning. This petrol uses increased amounts of ingredients called *antiknock hydrocarbons* to replace the TEL. The diagrams below show the proportion of hydrocarbons and TEL in two blends of 94-octane petrol.

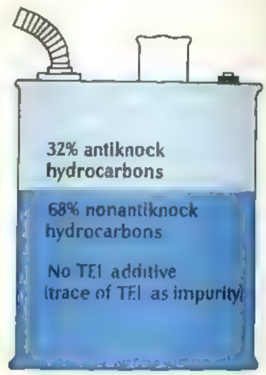
**The octane number** of a petrol indicates how smoothly it will burn in an engine. The table shows the average research octane number (RON) for the three different UK petrol grades.

| Grade | Octane number |
|---|---|
| Premium leaded | 97 |
| Premium unleaded | 98 |
| Regular unleaded | 95 |

**A leaded petrol** has a high percentage of nonantiknock hydrocarbons. It therefore requires TEL to resist knocking.




**An unleaded petrol** contains a greater proportion of antiknock hydrocarbons. It needs no TEL to burn smoothly.




a reference fuel containing 90 per cent isooctane, its octane number is 90. Petrols with better antiknock properties than pure isooctane have octane numbers above 100. Such numbers are measured with a reference fuel containing pure isooctane and chemical antiknock compounds, such as *tetraethyl lead* (see **Tetraethyl lead**). As car engines age, microscopic deposits form in the engine. These deposits cause engines to require petrol with a higher octane number for knock-free operation. Thus, older cars often need higher-octane fuels.

Car engineers measure octane number in three ways. Thus, every petrol has three octane numbers: (1) a *research octane number* (*RON*), (2) a *motor octane number* (*MON*), and (3) a *road octane number*. The RON is determined in a special one-cylinder engine in a laboratory. The MON is also determined in a test engine but under conditions more like those found in an ordinary engine. The road octane number is determined by comparing the petrol with various reference fuels in a moving car. People generally use either the RON or an average of the RON and the MON to describe a petrol's antiknock quality.

The RON is the highest octane number, the MON is from 6 to 10 numbers less, and the road octane number is somewhere between the two. For example, a petrol with a RON of 95 may have a MON of 87 and a road octane of 90. The octane number quoted on the pump at a petrol station is usually the average of the RON and the MON.

## Petrol additives

Petrol manufacturers make two types of fuel for cars —*leaded* and *unleaded*. Leaded petrols contain a small amount of the antiknock compound tetraethyl lead. Unleaded petrols do not contain tetraethyl lead.

Although tetraethyl lead performs well as an antiknock ingredient, it pollutes the air with poisonous lead compounds when burned in an engine. Lead in a car's exhaust fumes also prevents the effective use of special devices called *catalytic converters*, which can reduce other air pollutants in the exhaust.

The engines that power many of today's cars can use fuels with lower octane ratings. Their design allows for the use of petrol without lead compounds, which in turn enables the engines' catalytic converters to function effectively. These unleaded petrols are made with hydrocarbons that have high antiknock properties. Some refiners also add special oxygen-containing chemicals to these fuels to increase their octane numbers.

Petrols also contain a number of other additives. *Antioxidants* keep the petrol from becoming gummy. *Antifreeze* prevents ice from clogging fuel lines in winter. *Antirust* agents prevent tanks and fuel lines from rusting. *Detergents* and *deposit modifiers* clean off or prevent engine deposits caused by the burning of petrol. *Metal deactivators* keep small amounts of metal impurities from changing the properties of petrol.

## Petrol blends

Every brand of petrol is a blend of different hydrocarbons. The blend changes daily, depending on refinery conditions, so that the petrol has a constant octane number. Manufacturers also blend petrol types to make engines run better at various altitudes, in different climates, and during different seasons. For example, in summer or in hot climates, petrol refiners prepare blends containing few hydrocarbons that boil at low temperatures. The heat turns such hydrocarbons into a vapour. If the petrol contained many of these hydrocarbons, the resulting vapour could cause *vapour lock*, which stops the flow of petrol to the engine. Petrol blended for winter or cold climates contains some hydrocarbons that vaporize at a low temperature and thus enable a cold engine to start easily.

### History

In the early days of the petroleum industry, during the late 1800's, paraffin ranked as by far the leading product of refineries. Refiners considered petrol a useless by-product. The industry, when refining paraffin from crude oil, produced more petrol than could possibly be used. Refineries threw away most of the petrol. People used small amounts of petrol, then called *stove naphtha,* in cookers built to burn it.

The mass production of cars, which began in 1908, greatly increased demand for petrol. In 1913, refiners introduced a process that *cracked* (broke down) heavy hydrocarbons into the lighter ones used in petrol.

Today, efforts have been made to control air pollution resulting from the exhaust fumes from petrol engines of motor vehicles. In the United States, the federal Clean Air Amendments of 1970 required sharp reductions of hydrocarbons and carbon monoxide emissions. To meet the emission standards, most new cars in the U.S.A. have catalytic converters and therefore require unleaded petrol.

In the early 1970's, petroleum refiners had difficulty in meeting petrol demand. Political instability in the Middle East reduced petroleum production. Many countries reduced speed limits, and people were encouraged to use public transportation to save petrol.

The world's limited supply of petroleum led to increased efforts to conserve petrol, including the production of smaller cars with more fuel-efficient engines. Such efforts eventually led to a lower demand for petrol, helping to eliminate the severe shortages that had occurred during the 1970's.

See also **Air pollution; Gasohol; Transportation** (Problems of modern transportation).

**Petrol engine** is an engine that uses petrol as a fuel. Inside the engine, the *combustion* (burning) of fuel mixed with air produces hot gases that expand against parts of the engine and cause them to move. For this reason, petrol engines are called *internal-combustion* engines. The motion inside the engine is transferred outside it to turn wheels and propellers or to operate machines. In this way, a petrol engine turns heat energy into mechanical work. The rate at which a petrol engine produces work is usually measured in horsepower or watts (see **Horsepower**).

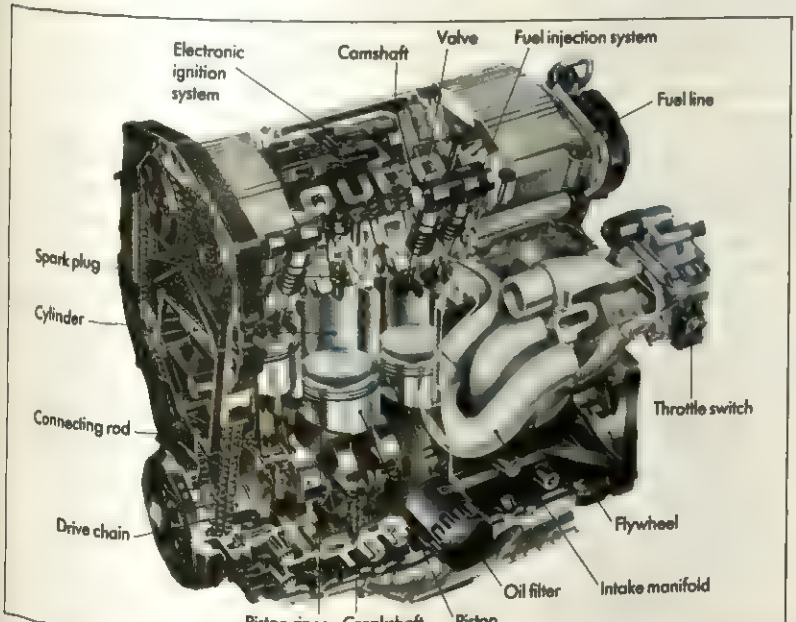
Petrol engines are compact and light in weight for the power they produce. This makes them one of the most important types of engines for vehicles. Nearly all cars, lawn mowers, motorcycles, motor scooters, snowmobiles, and small tractors have petrol engines. So do many trucks, buses, aeroplanes, and small boats. Petrol engines may also be used as portable power plants—for example, to supply the power to run pumps and other machinery on farms.

### Kinds of petrol engines

There are two main types of petrol engines, *reciprocating engines* and *rotary engines.* Reciprocating engines have pistons that move up and down or back and forth. A part called a *crankshaft* changes this reciprocating motion into rotary motion. A rotary engine, also known as a *Wankel* engine, uses devices called *rotors* instead of pistons. The rotors produce rotary motion directly. This article discusses reciprocating engines, the more common type. For information on rotary engines, see the *World Book* article on **Rotary engine.**

Reciprocating petrol engines are classified in a number of ways. These include (1) by the number of piston strokes per cycle, (2) by the type of compression, (3) by the way they are cooled, (4) by their valve arrangement, (5) by their cylinder arrangement, and (6) by the way they are supplied with air and fuel.

**Cycle.** Most reciprocating petrol engines operate on either a two-stroke or a four-stroke cycle. *Cycle* means the steps that must be repeated for each combustion of




**Basic parts of a petrol engine**

Reciprocating petrol engines have the same basic parts. As the pistons move up and down, connecting rods turn the crankshaft. This cut-away diagram shows the parts of a four-cylinder car engine. Like many other engines today, it has an electronic ignition system for easy starting. It also has a fuel injection system instead of a carburettor for better fuel economy.

**Petrol engine cylinder arrangement**

V-type engines have two rows of cylinders set at an angle. In-line engines have one row of cylinders. The cylinders of horizontal-opposed engines are opposite one another. Those of radial engines are set around the crankshaft. Rotary engines have rotor chambers instead of cylinders.


the fuel-air mixture in the cylinders. *Stroke* means the up-and-down or back-and-forth movements of the pistons. A *four-stroke* cycle engine has intake, compression, power, and exhaust strokes. A *two-stroke* cycle engine combines the exhaust and intake steps near the end of the power stroke. Although two-stroke cycle engines are less fuel-efficient than four-stroke cycle engines, they are simpler and cheaper to build. A two-stroke cycle engine is used where low cost is important, as in a power lawn mower. It delivers more power for a given weight and size than does a four-stroke cycle engine. Each cylinder in a two-stroke cycle engine produces a power stroke for every turn of the crankshaft. But in a four-stroke cycle engine, a cylinder produces a power stroke on every other turn.

**High and low compression.** As a piston moves from the bottom to the top of a cylinder, it compresses the air and petrol mixture. A number, called the *compression ratio,* tells how much the mixture is compressed. A high-compression engine may have a compression ratio of 10 to 1. Such an engine compresses the mixture to a tenth of its original volume. A low-compression engine may have a ratio of 8 to 1.

High-compression engines burn petrol more efficiently than do low-compression engines. But high-compression engines require high-octane petrol (see **Octane number**). Until the 1970's, the octane level of petrol depended on the amount of lead additives—the more lead, the higher the octane. In the mid-1970's, manufacturers began to equip cars with devices called *catalytic converters* that reduce the pollutants in car exhausts. Lead was found to interfere with the effectiveness of catalytic converters. Cars with catalytic converters had to use low-octane petrol because high-octane lead-free petrol was costly to produce. As a result, the car industry reduced compression ratios so that engines could burn lower octane lead-free fuels efficiently.

**Cooling.** The burning fuel-air mixture in a cylinder produces gas temperatures of about 2500° C. Therefore, the metal parts of the engine must be cooled or they would melt. Most automotive petrol engines are *liquid cooled.* A liquid, usually water, is circulated around the cylinders to cool the metal. The heated liquid is then pumped through a radiator. A fan driven by the engine or by an electric motor draws air through the radiator to cool the liquid.

Most aircraft reciprocating engines are *air cooled* to reduce weight. Air is not as effective a coolant as liquids, so the outsides of the cylinders have many metal fins. These fins conduct heat out of the cylinder and offer a large surface area for the air to sweep over, thus ensuring effective cooling.

**Valve arrangement.** The two most common valve arrangements are (1) L-head and (2) I-head. An *L-head,* or *underhead,* valve engine has the intake and exhaust valves side by side in the cylinder block. The *intake* valve admits the air-fuel mixture into the cylinder and the *exhaust* valve lets out the exhaust gases. An *I-head,* or *overhead,* valve engine has the two valves side by side in the cylinder *head,* the cylinder block's top cover. In some cars, each cylinder has four valves—two intake valves and two exhaust valves.

**Cylinder arrangement.** Engines are also classified by the number and arrangement of cylinders. The most common types include *in-line, V, radial,* and *horizontal opposed.* Radial engines have an odd number of cylinders, such as 3, 5, 7, or 9. Most other engines have an even number of cylinders—4, 6, 8, or 12.

**Air and fuel.** Fuel may be *metered,* or sent, to the cylinders by either a carburettor or an injection system. Therefore, reciprocating engines are also classified as *carburetted* or as *fuel-injected* engines (see **Carburettor; Fuel injection**). Because combustion depends upon both air and fuel, the power of an engine is limited by the amount of air reaching the cylinders. To increase power, an engine may be *supercharged* or *turbocharged.* A *supercharger* is an engine-driven pump, and a *turbocharger* is an exhaust-driven pump. Both pumps force extra air into the cylinders, increasing the engine power. The air needed to burn 1 unit of petrol weighs about 15 times as much as the petrol.

### Parts of a reciprocating petrol engine

**Cylinder block** is a rigid frame that holds the cylinders in proper alignment. If the engine is liquid cooled, the block is *jacketed,* so that it can be surrounded by the liquid, or has passages for the liquid around each cylinder. In automotive engines, the cylinder block and crankcase form a single unit. Most cylinder blocks are made of cast iron or aluminium.

**Cylinders** are rigid tubes that serve as a bearing for the pistons that move up and down inside them. They have highly polished surfaces. This permits a close fit between piston and cylinder and prevents gases from leaking past the piston. The cylinders in most car engines are part of the block. Some engines have a cylinder *sleeve* made of specially hardened steel or cast iron pressed into the cylinder block.

**Cylinder head** is a casting bolted to the top of the cylinder block. The cylinder head, together with the upper end of the cylinder and the top of the piston,

form the *combustion chamber* where the fuel-air mixture burns. A cylinder head and block may be one unit.

**Crankcase** is a rigid frame that holds the crankshaft and the crankshaft bearings. In small engines, all or part of the crankcase may be a part of the cylinder block.

**Pistons and connecting rods.** When the fuel-air mixture burns, the expanding gases exert a force on the *piston.* This force is then transmitted through a *connecting rod* to the crankshaft. The piston has two to six rings to prevent the gases from escaping and to keep lubricating oil from getting into the combustion chamber.

**Crankshaft** changes the reciprocating motion of the pistons into rotary motion. The crankshaft has a number of cranks, or *throws.* These cranks are displaced at angles to each other. For example, in a six-cylinder, in-line, four-stroke cycle engine, the cranks are displaced at 120° angles to each other. As a result, the engine delivers three equally spaced power strokes in each revolution of the crankshaft to assure smooth operation.

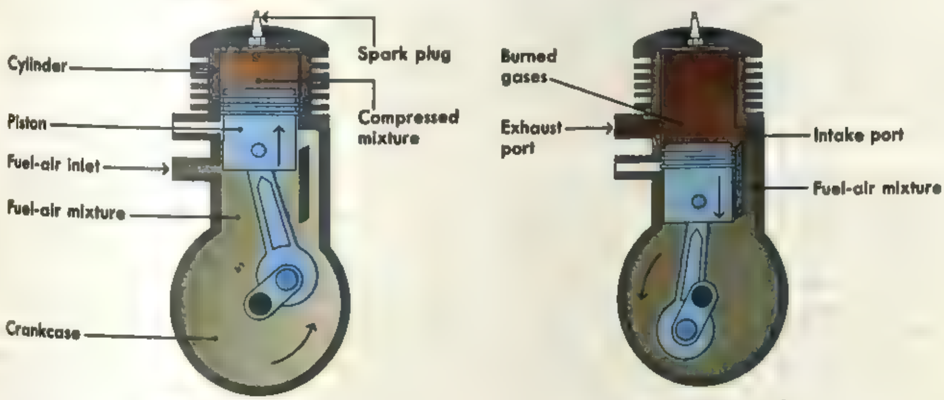
**Flywheel** stores energy during a piston's power stroke and releases it during other strokes. This helps to keep the crankshaft turning at a constant speed (see **Flywheel**).

**Valves.** In a four-stroke cycle engine, each cylinder has one or two intake valves, to let the air-fuel mixture into the combustion chamber, and one or two exhaust valves, to let the burned gases escape. These are called *poppet valves,* because they pop up and down as they open and close. The opening in the cylinder block or head uncovered by the valve is called the *port.* In many two-stroke cycle engines, the movement of the piston takes the place of separate valves. As the piston moves, it covers and uncovers the ports.

**Camshaft** opens and closes the valves at the proper point in the engine cycle. It runs the length of the engine and has one *cam* (lobe) at each intake and exhaust valve. In a four-stroke cycle engine, the camshaft is geared to the crankshaft so that it runs at half the crank-

**How a two-stroke cycle petrol engine works**

A cycle begins when the piston moves up the cylinder during the intake-compression stroke, *below left.* The piston sucks a fuel-air mixture into the crankcase for the next cycle and compresses the mixture already in the cylinder. When the piston reaches the top, the spark plug ignites the mixture. Burning gases push the piston down for the power-exhaust stroke, *below right.* As the piston uncovers the exhaust port, the gases escape and a fresh mixture enters the cylinder through the intake port.

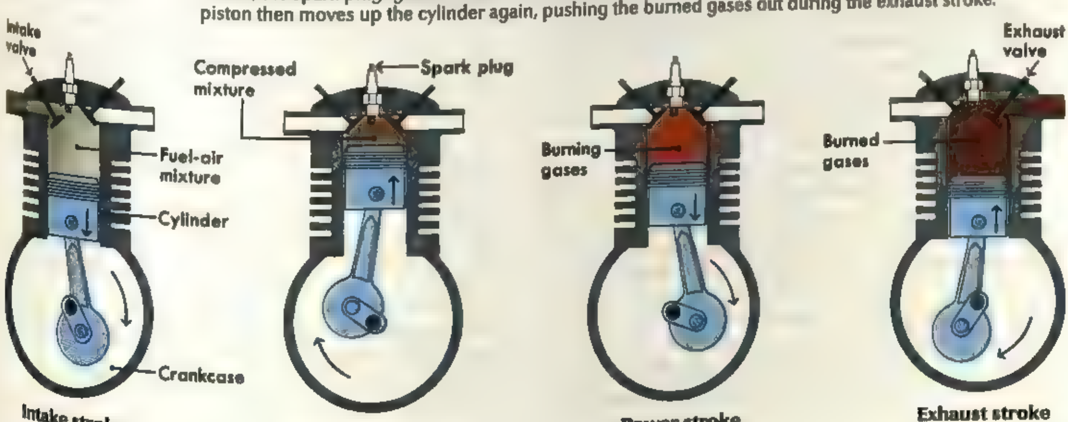



**Intake-compression stroke**

**Power-exhaust stroke**

**How a four-stroke cycle petrol engine works**

A cycle begins with the intake stroke as the piston moves down the cylinder and draws in a fuel-air mixture. Next, the piston compresses the mixture while moving up the cylinder. At the top of the compression stroke, the spark plug ignites the mixture. Burning gases push the piston down for the power stroke. The piston then moves up the cylinder again, pushing the burned gases out during the exhaust stroke.




**Intake stroke**

**Compression stroke**

**Power stroke**

**Exhaust stroke**

shaft's speed. The camshaft may be located in the head of an overhead valve engine, or in the crankcase.

**Fuel system** includes (1) a *storage tank* for petrol, (2) *fuel lines* to carry the petrol to the carburettor, (3) a *carburettor* to mix the petrol with air, and (4) an *intake manifold* to distribute the fuel-air mixture to the cylinders. The fuel system also includes a *filter* to clean dirt out of the fuel and an *air cleaner* to take dirt out of the air that is mixed with the petrol. In addition, the system may include a *governor* to limit the engine's speed. See **Carburettor; Governor.**

Some petrol engines have a *fuel injection system* instead of a carburettor. Fuel injection controls and distributes the fuel-air mixture better than a carburettor does. It can improve fuel economy and reduce exhaust emissions. See **Fuel injection.**

**Exhaust system** consists of one or more parts. It may include (1) an *exhaust manifold* to collect the burned gases from the cylinders, (2) an *exhaust pipe* to carry the burned gases, and (3) a *silencer* to silence the noise of the exhaust gases. See **Silencer.**

**Ignition system** is the electrical circuit necessary to set fire to, or *ignite*, the fuel-air mixture in the different cylinders at different times. In a car a *storage battery* provides electric current, which is increased in voltage by an *induction coil*. The high-voltage current is carried through a *distributor*, which delivers the electricity to each cylinder at about the moment the piston reaches the top of the compression stroke. There the electric current jumps a gap between two terminals and sets fire to the petrol-air mixture. The terminals are encased in insulating material and called a *spark plug*. See **Battery; Ignition.**

Some car engines have an electronic ignition system. These systems use electronic parts, such as capacitors and transistors, to produce the ignition voltage and to control it. Electronic ignition systems may use a distributor to deliver the electricity to each cylinder, or the electricity may be delivered directly to the cylinders. Electronic systems require less maintenance than do ordinary systems, and they provide better engine performance.

In an aeroplane engine, the high-voltage electric current may be generated by a *magneto* and carried to the spark plugs. A magneto does not require a battery to operate. See **Magneto.**

**Lubrication system** provides oil as a film between the moving parts of the engine to prevent wear from friction and to keep the engine cool. The two common types of four-stroke cycle engine lubrication systems are the *wet sump* and the *dry sump*. In the wet-sump engine, the oil supply is contained within the engine, in the bottom of the crankcase. In the dry-sump engine, the oil supply is contained in a separate oil tank.

Some two-stroke cycle engines, such as those used on lawn mowers, motorcycles, and boats, have no separate lubrication system. Users of these engines mix a small amount of lubricating oil with the petrol. Larger heavy-duty two-stroke cycle engines have lubrication systems similar to those on four-stroke cycle engines.

## Development of the petrol engine

Early internal-combustion engines used gases instead of petrol as fuel. The Reverend W. Cecil read a paper before the Cambridge Philosophical Society in England, in 1820, describing experiments with an engine driven by the explosion of a mixture of hydrogen and air. It is believed to be the earliest working gas engine.

Another English inventor, William Barnett, in 1838 patented a gas engine which compressed the fuel mixture. Barnett's engine had a single up-and-down cylinder with explosions occurring first at the top, then at the bottom, of the piston.

In France, Jean Joseph Étienne Lenoir built the first practical internal combustion engine in 1860. It used street-lighting gas for fuel. This single-cylinder engine had an *accumulator* (storage-battery) ignition system. By 1865, 400 of these engines were in use in Paris for such jobs as powering printing presses, lathes, and water pumps. Lenoir installed one of his gas engines in a crude motor vehicle.

In 1862 another Frenchman, Beau de Rochas, worked out on paper the idea of the four-cycle engine. But he did not build one. Four years later Nikolaus August Otto and Eugen Langen of Germany built a successful four-cycle gas engine.

The first successful four-cycle engine to burn petrol was designed in 1885 by Gottlieb Daimler, an associate of Otto and Langen. In the same year, Karl Benz, another German, also developed a successful petrol engine. These engines were basically the same as petrol engines built today. For later development of the petrol engine, see **Car.**

## Air pollution controls

Car petrol engines produce certain air pollutants. Most industrialized countries have set legal limits on the amount of pollutants cars and other road traffic may produce. To meet these standards, some car manufacturers have made a number of modifications in engine design. They have begun to install catalytic converters on new cars to reduce emissions of pollutants (see Car [Air pollution; Emission control system]). Today, cars with electronic engine control have a device called an *oxygen sensor* in the exhaust system. The sensor signals the electronic engine control to adjust the fuel-air mixture for the most effective operation of the catalytic converter. Sometime in the future, cars may run on hydrogen in order to reduce pollution. The main product of combustion is harmless water vapour.

**Related articles** in *World Book* include:

**Parts of a petrol engine**

| | | |
|---|---|---|
| Battery | Fuel injection | Induction coil |
| Carburettor | Governor | Magneto |
| Flywheel | Ignition | Starter |

**Other related articles**

| | | |
|---|---|---|
| Aeroplane (Reciprocating engines) | Daimler, Gottlieb | Petrol |
| Antifreeze | Diesel engine | Rotary engine |
| Benz, Karl | Engine analyser | Transmission |
| Car | Free-piston engine | Turbine (Gas turbines) |
| Catalytic converter | Horsepower | Vapour lock |
| | Lenoir, Jean Joseph Étienne | |

**Petrolatum,** also called *petroleum jelly*, is a colourless to yellow, jellylike substance made from petroleum. Petrolatum is used as an ingredient in medicines and cosmetics. It is also sold in the jellylike state, often under the trade name *Vaseline*. See also **Mineral oil.**


**Most petroleum** comes from the earth as a liquid called *crude oil*. Different types of crude oil differ in colour and thickness, ranging from a clear, thin fluid to a dark, tarlike substance. In some parts of the world, petroleum also occurs as a solid in certain sands and rocks.

# Petroleum

**Petroleum** is one of the most valuable natural resources in the world. Some people call petroleum *black gold*, but it may be better described as the lifeblood of industrialized countries. Fuels made from petroleum provide power for cars, aeroplanes, factories, farm equipment, trucks, trains, and ships. Petroleum fuels also generate heat and electricity for many houses and business premises. Altogether, petroleum provides nearly half the energy used in the world.

In addition to fuels, thousands of other products are made from petroleum. These products range from paving materials to drip-dry fabrics and from engine grease to cosmetics. Petroleum is used to make such items in the home as aspirins, carpets, curtains, detergents, records, plastic toys, and toothpaste.

Although we use a huge variety of products made from petroleum, few people ever see the substance itself. Most of it comes from deep within the earth as a liquid called *crude oil*. Different types of crude oil differ in thickness and colour, ranging from a thin, clear oil to a thick, tarlike substance. Petroleum is also found in solid form in certain rocks and sands.

The word petroleum comes from two Latin words meaning *rock* and *oil*. People gave it this name because they first found it seeping up from the earth through cracks in surface rocks. Today, petroleum is often referred to simply as *oil*, and most of it is found in rocks far beneath the earth's surface.

People have used petroleum for thousands of years. But few people recognized its full value until the 1800's, when the paraffin lamp and the motorcar were invented. These inventions created an enormous demand for two petroleum fuels, *paraffin* (also called *kerosene*) and *petrol* (also called *gasoline*). Since about 1900, scientists have steadily increased the variety and improved the quality of petroleum products.

Petroleum, like other minerals, cannot be replaced after it has been used. People are using more and more petroleum each year, and the world's supply is rapidly running out. If present rates of consumption continue, petroleum may become scarce sometime in the mid-2000's.

Most industrialized nations depend heavily on imported petroleum to meet their energy needs. As a result of this dependence, oil-exporting countries have been able to use petroleum as a political and economic weapon by restricting exports to some of these nations. Oil exporters have also strained the economies of a large number of countries, particularly the poorer ones, by drastically increasing the price of petroleum. Many nations, rich as well as poor, have suffered petroleum shortages since the early 1970's.

To prevent a full-scale energy shortage, scientists are experimenting with artificial forms of oil and with other sources of fuel. But even if new energy sources appear quickly, people will have to rely on petroleum for many years. Conservation of oil has thus become urgent for every country. People now need to be inventive in finding ways to conserve petroleum.

**Derricks and refineries** are familiar symbols of the petroleum industry. A tall steel derrick, *left,* supports the equipment used to drill deep into the earth for petroleum. In a refinery, *right,* crude oil is processed into fuels and other valuable products.

## The uses of petroleum

Petroleum has a greater variety of uses than perhaps any other substance in the world. The reason petroleum has so many uses lies in its complicated molecular structure. Crude oil is chiefly a mixture of many different *hydrocarbons,* which are made up of the elements hydrogen and carbon. Some of these hydrocarbons are gaseous and some are solid, but most are liquid.

The mixtures of different hydrocarbons give special characteristics to the *fractions* (parts) of petroleum. Some fractions, such as petrol and kerosene, are valuable in their natural liquid state. Others must be converted from one state to another or combined with different substances before they can be used.

Various types of crude oil contain different amounts of certain fractions. *Light crudes* have large amounts of dissolved gases, petrol, and other light fractions. Most

### Petroleum terms

**Barrel** is the standard unit used to measure crude oil and most petroleum products. One barrel equals 159 litres.

**Bituminous sands,** or *tar sands,* are grains of sand surrounded by a black substance that can be processed into oil or gas.

**Bringing in a well** means to start the oil flowing in a well.

**Crude oil** is oil as it occurs naturally in a reservoir.

**Derrick** is a tall steel structure that holds the equipment used to drill an oil well.

**Dry hole** is a well that fails to produce oil or gas in commercial quantities.

**Enhanced recovery** is any method of adding energy to a reservoir to force oil to flow into a producing well.

**Fraction** is any of the groups of hydrocarbons that make up crude oil. Fractions are separated during refining.

**Hydrocarbon** is a chemical compound made up of the elements hydrogen and carbon.

**Mineral lease** is an agreement between an oil company and a property owner. It gives the company the right to drill for, and to produce, oil on the property.

**Offshore wells** are wells drilled in oceans, seas, or lakes.

**Oil field** is an area that contains one or more reservoirs.

**Oil shale** is a sedimentary rock containing *kerogen,* a substance that can be processed into oil.

**Oil trap** is a nonporous, underground rock formation that blocks the movement of oil and so seals off a reservoir.

**Petrochemicals** are chemicals processed from oil and gas.

**Primary recovery** is a method in which the natural energy in a reservoir is used to bring oil into a producing well.

**Reservoir** is an accumulation of petroleum below the earth's surface. It consists of tiny drops of oil that collect in the pores of such rocks as limestone and sandstone.

**Rig** consists of the derrick, hoisting machinery, and other equipment used in drilling an oil well.

**Roughneck** is a worker on a drilling crew.

**Royalty** is money paid to landowners for oil produced on their property. Most oil companies pay a royalty of one-eighth to one-sixth of the value of each barrel of oil produced and sold. Landowners may also take royalties in oil.

**Wildcat well** is a well drilled in an area where no oil or gas has been found.

*heavy crudes* have a high proportion of heavy oils and asphalt. All crude oil contains some substances in addition to hydrocarbons. These impurities, which include metallic compounds and sulphur, may make up as much as 10 per cent of some types of oil.

Petroleum refineries separate the various fractions and change them into useful products. Most crude oil is refined into petrol, heating oil, and other fuels. The rest of the oil is converted chiefly into industrial raw materials and lubricants.

**Petroleum as a fuel.** Petroleum fuels ignite and burn readily and produce a great amount of heat and power in relation to their weight. They are also easier to handle, store, and transport than such other fuels as coal and wood. Petroleum is the source of nearly all the fuels used for transportation and of many fuels used to produce heat and electricity.

*Fuels for transportation* include petrol, diesel fuel, and jet fuel. About 45 per cent of all crude oil is refined into petrol, about 7 per cent into diesel fuel, and about 7 per cent into jet fuel.

Petrol is classified into regular, premium, and aviation grades, according to how smoothly it burns in an engine. Most motor vehicles and all piston-engine aeroplanes use petrol. Diesel fuel requires less refining and is cheaper than petrol. Nearly all trains, ships, and large trucks use diesel fuel. Jet aeroplanes burn jet fuel, which is either pure kerosene or a mixture of petrol, kerosene, and other fuels.

*Fuels for heating and energy production* account for about 26 per cent of all refined petroleum. Such fuels may be classed as *distillate oils* or *residual oils*. Distillate oils are lighter oils, most of which are used to heat houses and small business premises. Residual oils are heavier, thicker oils. They provide power for electric utilities, factories, and large ships. Residual oils are also used to heat large buildings.

Many people who live on farms or in mobile homes use *liquefied petroleum gas* (LPG) for heating and cooking. LPG consists chiefly of butane and propane gases that have been converted under pressure into liquids. LPG is used in industry for cutting and welding metals and on farms for operating various kinds of equipment.

**Petroleum as a raw material.** About 13 per cent of petroleum fractions serve as raw materials in manufacturing. Many of these fractions are converted into *petrochemicals*. Petrochemicals are used in manufacturing cosmetics, detergents, drugs, fertilizers, insecticides, plastics, synthetic fibres, and hundreds of other products.

By-products of petroleum refining are also used as raw materials in certain industries. These by-products include asphalt, the chief roadbuilding material, and wax, an essential ingredient in such products as candles, milk cartons, and furniture polish.

**Other uses of petroleum.** Such products as lubricants and specialized industrial oils account for about 2 per cent of petroleum production. Lubricants reduce friction between the moving parts of equipment. They range from the thin, clear oil used in scientific instruments to the heavy grease applied to aircraft landing gear. Specialized industrial oils include *cutting oils* and *electrical oils*, which are used in manufacturing.

## Where petroleum is found

Petroleum is found on every continent and beneath every ocean. But present-day techniques enable petroleum engineers to *recover* (bring to the surface) only about a third of the oil in most deposits. These recoverable amounts of petroleum are called *reserves*.

Petroleum experts estimate that the world's oil reserves total about 1 trillion barrels. Some geologists predict that additional reserves will be discovered, particularly in China, on Canadian islands in the Arctic Ocean, and in offshore seabeds. However, many experts think that most of the major oil fields have already been found. They believe that world reserves are more likely to be increased by better methods of recovery.

**The Middle East** has about 67 per cent of the world's oil. Its reserves total about 660 billion barrels. Saudi Arabia has about 258 billion barrels, or about a quarter of the world's reserves. Most of Saudi Arabia's petroleum lies in areas along the Persian Gulf. Abu Dhabi, Iran, Iraq, and Kuwait each have about a 10th of the total world petroleum reserves.

**Europe,** including the Asian part of Russia, has about 8 per cent of the world's oil supply. Russia, with about 57 billion barrels, has the largest reserves in the region. Most of these reserves lie west of the Ural Mountains, though there are several large oil fields in Siberia. The only other major European reserves, which amount to about 17 billion barrels, are beneath the North Sea. These reserves belong chiefly to the United Kingdom and Norway.

**Some uses of petroleum products**

**Fuels**

**For transportation**

| | |
|---|---|
| Aviation petrol | Paraffin |
| Diesel fuel | Petrol |
| Jet fuel | |

**For heating and energy production**

| | |
|---|---|
| Distillate oils | Residual oils |
| Liquefied petroleum gas (LPG) | |

**Raw materials**

| | |
|---|---|
| Asphalt | Industrial hydrogen |
| Carbon black | Naphtha |
| Coke | Wax |

**Miscellaneous oils**

| | |
|---|---|
| Lubricating oils and greases | Road oils |
| Medicinal oils | Technical oils |

**Petrochemicals**

| | |
|---|---|
| Alcohol | Petrol additives |
| Ammonia | Ink |
| Cosmetics | Insecticides |
| Drugs | Paint |
| Dyes | Plastics |
| Explosives | Resins |
| Fertilizers | Solvents |
| Fibres | Synthetic rubber |
| Food additives | |

**Latin America** has about 120 billion barrels of petroleum reserves, or about 12 per cent of the world's total. Venezuela has the largest reserves in the region, about 59 billion barrels. Mexico has the second largest reserves in Latin America, about 52 billion barrels. Other Latin American countries with important petroleum deposits are Argentina and Brazil.

**Africa** possesses about 60 billion barrels of oil, or 6 per cent of the world's reserves. Most of the oil lies in Libya, Algeria, and other countries in northern Africa. Libya's reserves of about 23 billion barrels rank as the region's largest. South of the Sahara, large amounts of oil have been found only in Nigeria, which has about 17 billion barrels.

**Asia,** excluding the Asian part of Russia and the Middle East, has about 50 billion barrels of oil, or 5 per cent of the world's reserves. About half these reserves lie in China. China's largest oil field is at Daqing in Manchuria. Indonesia, with about 11 billion barrels, has the second largest reserves in the Far East.

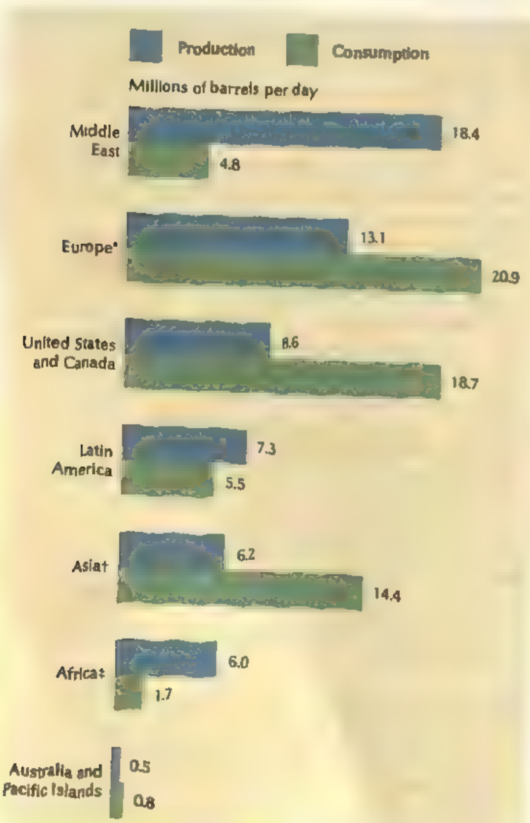
**The United States and Canada** have about 32 bil-lion barrels of oil, which amounts to 3 per cent of the world total. The United States has about 26 billion bar-rels of petroleum. Most of these reserves lie in Texas, Louisiana, California, Oklahoma, and Alaska. In time, U.S. reserves may be increased by oil produced from *oil shale,* a type of rock that is plentiful in Colorado, Wyo-ming, and Utah. Oil shale contains *kerogen,* a waxy sub-stance that yields oil when heated.

Most of Canada's 6 billion barrels of oil lie in the province of Alberta. Saskatchewan, British Columbia, and Manitoba also have oil fields. In addition, geologists believe that Canada has the world's largest deposits of *bituminous sands,* or *tar sands* (sands soaked with an oil-producing substance). These deposits, which are es-timated to contain up to a trillion barrels of oil, lie along the Athabasca River in Alberta. Production of oil from the sands began in 1967.

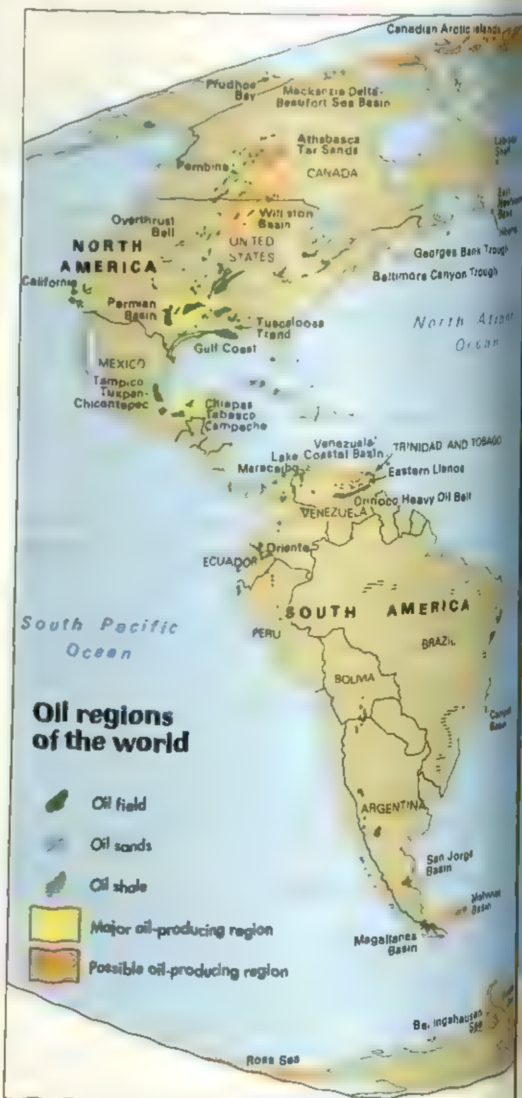
**Australasia** has oil reserves of about 2.5 billion bar-rels, less than one-third of 1 per cent of the world total.

**World production and consumption of petroleum**

This graph shows the amounts of petroleum produced and used in various regions of the world. The Middle East produces about three times as much petroleum as it consumes. However, most regions consume more oil than they produce.




*Includes the Asian part of the former Soviet Union.
†Excludes the Asian parts of the Middle East and the former Soviet Union.
‡Excludes the African part of the Middle East.
Figures are for 1992.
Source: U.S. Energy Information Administration.



The greatest part of these reserves lie in Australia. Australia and New Zealand have both offshore and onshore oil-bearing areas. New Zealand and Papua New Guinea have about 200 million barrels each.

### How petroleum was formed

Most geologists believe that petroleum was formed from the remains of organisms that died millions of years ago. This *organic theory* of petroleum formation is based on the presence of certain carbon-containing substances in oil. Such substances could have come only from once-living organisms. The same process that produced petroleum also produced natural gas. Thus, natural gas is often found in association with crude oil or dissolved in it.

According to the organic theory, water covered much more of the earth's surface in the past than it does today. Masses of tiny organisms lived in shallow water or drifted around near the surface in the open ocean. As these organisms died, their remains settled to the bottom of the ocean and became trapped in *sediments* (particles of mud, sand, and other substances). The sediments piled up and became buried below the surface of the ocean floor.

As the sediments became buried deeper and deeper, they were subjected to increasingly high temperatures and pressures and so were compressed to form *sedimentary rock*. These conditions caused the rock to go through chemical processes that resulted in the formation of a waxy substance called *kerogen*. Kerogen separates into a liquid (oil) and a gas (natural gas) when heated to temperatures above about 100° C. But if the oil becomes buried too deeply and is exposed to temperatures higher than about 200° C, the bonds holding the large, complex oil molecules together weaken and the oil decomposes.

The temperature range in which oil can form is called the *oil window*. At temperatures below this range, little oil forms. At great depths, where temperatures are high, most oil decomposes.


This map locates the world's major deposits of crude oil, oil sands, and oil shale. It also locates the principal oil-producing regions and areas where oil might be produced. Oil is found on every continent and in many offshore seabeds. But about two-thirds of the world's oil lies in the Middle East. Russia is the world's largest oil producer, followed by the United States and Saudi Arabia. Possible oil-producing areas include the Arctic Ocean and Australia's offshore seabeds.

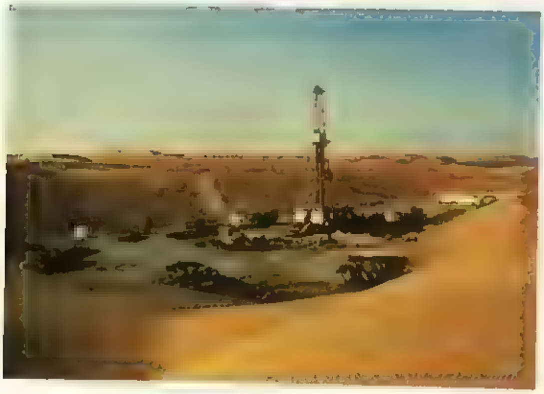
Over time, the oil and gas moved upwards through natural passageways in the rock. These passageways included cracks and tiny holes known as *pores.* Geologists believe this movement may have been caused by the presence of water in the rock. Water, which is heavier than oil, could have pushed the oil upward. Another possible cause was the weight of the overlying layers of rock, which would tend to squeeze the oil into holes and cracks in the rock.

Oil and gas escaped to a type of rock called *reservoir rock.* Such rock has two characteristics that enable fluids to move through it: (1) porosity and (2) permeability. Porosity is the presence of small openings, or pores. Permeability means that some of the pores are connected by spaces through which fluids can move. Oil and gas moved upward through the connected pore spaces until they reached an impermeable layer of rock. They continued to escape along the underside of the impermeable layer until that layer formed some sort of three-dimensional *trap.* Later, shifts in the earth's crust caused the oceans to draw back. Dry land then appeared over many reservoir rocks and traps.

The most common types of petroleum traps are *anticlines, faults, stratigraphic traps,* and *salt domes.* An anticline is an archlike formation of rock under which petroleum may collect. A fault is a fracture in the earth's crust, which can shift an impermeable layer of rock next to a permeable one that contains oil. Most stratigraphic traps consist of layers of impermeable rock that surround oilbearing rocks. In a salt dome, a cylinder- or cone-shaped formation of salt pushes up through sedimentary rocks, causing the rocks to arch and fracture in its path. Petroleum may accumulate above or along the sides of such a formation.

Most reservoirs and traps lie deep beneath the surface of the earth. However, some reservoirs have formed near the surface, and others have been shifted upward by changes in the earth's crust. Oil from these shallow deposits may reach the surface as *seepages* (trickles) or springs. In some places, such as Venezuela and the island of Trinidad, enough oil has collected at the surface to form a lake.

Today, the organic matter in some sedimentary deposits is being subjected to conditions of pressure, heat, and bacterial action similar to those that formed oil ages ago. But it takes millions of years for useful amounts of oil to develop. People are consuming petroleum much faster than it is being formed.



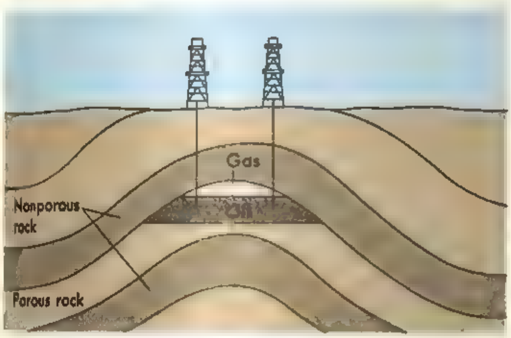
**The Middle East** has about two-thirds of the world's oil. About a quarter of the total reserves lie in Saudi Arabia. Many nations depend on Middle Eastern oil to meet their energy needs.

**Offshore wells** provide about 25 per cent of the oil produced in the world. The North Sea, which has some of the richest offshore deposits, is a major source of oil for Western Europe.

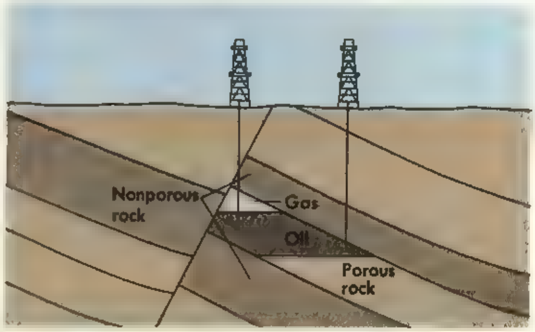
**Bituminous sands,** or *tar sands,* can be processed into petroleum. The world's largest deposits of these sands lie along the Athabasca River in the Canadian province of Alberta.

**Oil shale** yields oil when heated. Huge deposits of oil shale in the U.S. states of Colorado, Wyoming, and Utah may someday provide more oil than the oil fields of the Middle East.

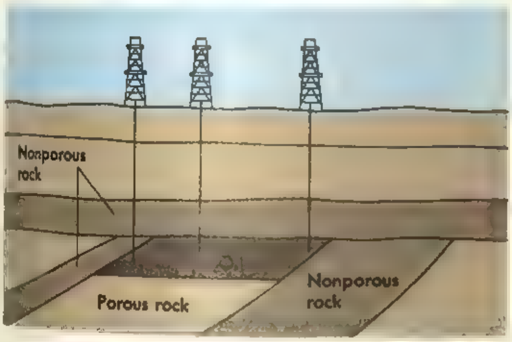
**Where petroleum is found** Most crude oil lies in underground formations called *traps.* In a trap, petroleum collects in the pores of certain kinds of rock. Gas and water are also present in most traps. The most common types of traps are *anticlines, faults, stratigraphic traps,* and *salt domes.*



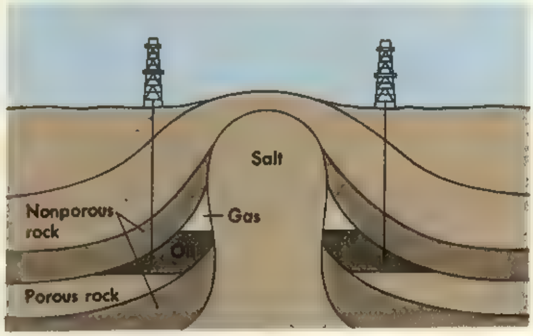

**An anticline is an archlike formation.**




**A fault is a fracture in the earth's crust.**




**A stratigraphic trap has horizontal layers of rock.**




**A salt dome is formed by a large mass of salt.**

## Exploring for petroleum

Before about 1900, petroleum prospectors could do little more than look for oil seepages and hope for luck. Their equipment consisted chiefly of a pick and a shovel. Today's prospectors use a variety of complicated instruments and are likely to be *oil geologists* or *geophysicists.*

**Geological studies.** Oil geologists study rock formations on and below the earth's surface to determine where petroleum might be found. They then make a detailed map of the surface features of the area. They may use photographs taken from aeroplanes and satellites in addition to their ground-level observations, particularly if the area is difficult to cover on foot. The geologists study the map for signs of possible oil traps. For example, the appearance of a low bulge on an otherwise flat surface may indicate the presence of a salt dome, a common petroleum trap.

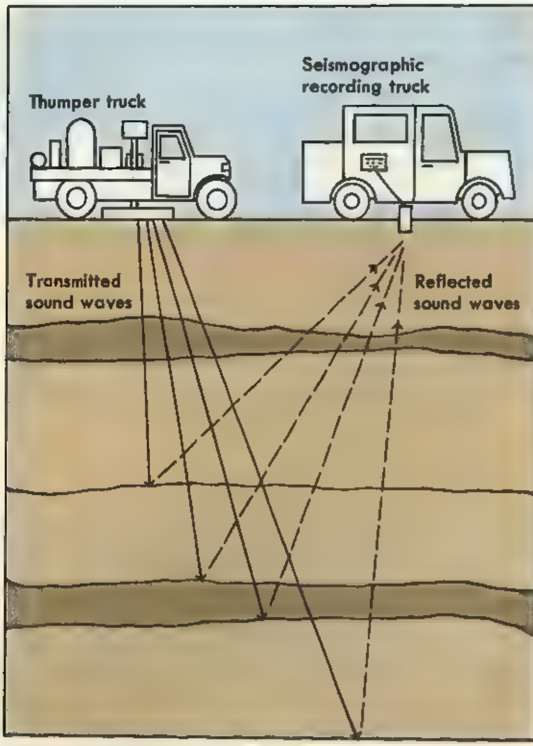
If the site looks promising, oil geologists may have holes drilled into the earth to obtain *cores,* which are cylindrical samples of the underground layers of rock. The geologists analyse the cores for chemical composition, structure, and other factors that relate to the formation of petroleum.

Oil geologists also study *well logs.* A well log is a record of the rock formations encountered during the drilling of a well. Well logs describe such characteristics as the depth, porosity, and fluid content of the rocks. Oil geologists can use this information to estimate the location and size of possible deposits in the area surrounding the wells.

**Geophysical studies.** Geophysicists provide oil geologists with detailed information about underground and underwater rock formations. Geophysicists can locate geological structures that may contain oil with the aid of special instruments. The most widely used instruments are (1) the gravimeter, (2) the magnetometer, and (3) the seismograph.

***The gravimeter,*** or gravity meter, measures the pull of gravity at the earth's surface. Different kinds of rocks have different effects on gravity. Nonporous rocks tend to increase gravitational pull, and porous rocks tend to decrease it. Low readings on a gravimeter may thus show the presence of possibly oilbearing, porous layers of rock.

***The magnetometer*** records changes in the earth's magnetic field. The magnetic pull of the earth is affected by the types of rocks beneath its surface. Sedimentary rocks generally have lower magnetism than other types of rock, which may contain iron and other magnetic substances. This difference in magnetic pull enables geophysicists to identify layers of sedimentary rock that may contain oil. Magnetic pull is also affected by structural irregularities, such as anticlines and faults. Magnetometers may thus detect certain petroleum traps.




**Sound waves can help find oil.** A method called *vibroseis* operates on the principle that the speed of sound waves varies according to the type of rock through which they travel. In this method, a *thumper truck* produces sound waves. Another truck holds a *seismograph,* an instrument that records the time taken for sound waves reflected by underground rocks to reach the surface. Vibroseis thus enables geophysicists to locate rocks that may contain oil.

***The seismograph*** measures the speed of sound waves travelling beneath the earth's surface. This speed depends on the type of rock through which the sound waves move. Geophysicists can use the speeds recorded by a seismograph to determine the depth and structure of many rock formations.

In a seismographic survey, geophysicists may set off a small explosion at or just below the earth's surface. The sound waves generated by the explosion travel to underground layers of rock and bounce back to the surface. The seismograph records how long it takes the sound waves to reach the surface. Many geophysicists use a system called *vibroseis* to eliminate the environmental risks of using explosives. In this system, sound waves are produced by a huge vibrator that repeatedly strikes the earth. The vibrator is mounted on a special truck called a *thumper truck.*

Geophysicists also conduct seismographic surveys of offshore areas. They send a compressed-air discharge from a ship into the water. The resulting sound waves are reflected from underwater formations to a string of *geophones* (sound detectors) that is towed behind the ship.

By means of a technique called *bright spot technology,* geophysicists can use seismographs to detect the presence of fluids in underground and underwater rock formations. This technique involves the use of highly sensitive recorders that pick up changes in the *amplitude* (strength) of sound waves. Sound waves change in amplitude when they are reflected from rocks that contain gas and other fluids. Such changes appear as irregularities, called *bright spots,* on the sound wave patterns recorded by the seismograph.

## Drilling an oil well

Drilling for petroleum is nearly always an enormous gamble. Most geological and geophysical studies indicate the places where petroleum might have accumulated. But there is less than a 10 per cent chance that oil is actually present in those places. There is only a 2 per cent chance that it is present in commercially useful amounts. Many *dry holes* may be drilled before a producing well is *brought in* and the oil begins to flow.

**Preparatory measures** take place both on and off the drilling site. These measures include (1) obtaining leases and permits, (2) preparing the site, and (3) rigging up.

***Obtaining leases and permits.*** In most countries, oil companies must deal with the owner of a site—or with the government if the site is on public property—for permission to drill. Many companies obtain a *mineral lease,* which gives them the right to drill wells and to produce oil and gas on the site. In return, the owner generally receives *royalties* (shares of the income) from any oil and gas recovered.

After obtaining a mineral lease, an oil company must usually get drilling permits from the national, provincial, and local governments. Before such permits are issued, a company has to meet certain requirements. In most cases a company must submit studies showing the effect drilling would have on the environment. A company must also show how it intends to conserve natural resources and prevent waste.

***Preparing the site.*** A drilling site must be flat and free of trees and brush to make room for drilling operations. In most locations, bulldozers are used to clear and level the ground. If an area has rough terrain or a harsh climate, additional preparation may be required. In the United States, for example, on Alaska's North Slope, drilling sites had to be reinforced with gravel and wood. If these measures had not been taken, the heat generated by the drilling equipment might have thawed the frozen soil and caused the wells to collapse.

Roads must be built to the drilling site. The site must also have a power plant and a water supply system. If the location is far from a city or town, or offshore, living quarters may have to be set up for the crew.

After the drilling site has been prepared, the construction crew brings in the *rig,* which consists chiefly of drilling equipment and a derrick. The rig may be transported by truck, bulldozer, barge, or aircraft, depending on the location of the site.

***Rigging up*** is the process of setting up and connecting the various parts of the rig. First, the construction crew erects the derrick over the spot where the well is to be drilled. Derricks serve mainly to hold the hoisting machinery and other drilling equipment. The hoisting machinery, which includes pulleys, reels, and heavy wire, lowers the drill into the well hole and hoists it out. Derricks range in height from about 25 to 60 metres, depending on the estimated depth of the oil. Most con-

struction crews use a *jackknife derrick,* which consists of two or more sections that can be easily transported and assembled on site.

Next, the crew installs the engines that power the drill and other machinery on the rig. The workers also assemble the various pipes, tanks, pumps, and other drilling equipment. After the drill is attached to the hoisting machinery, the well hole can be *spudded in* (started) by any of several methods of drilling.

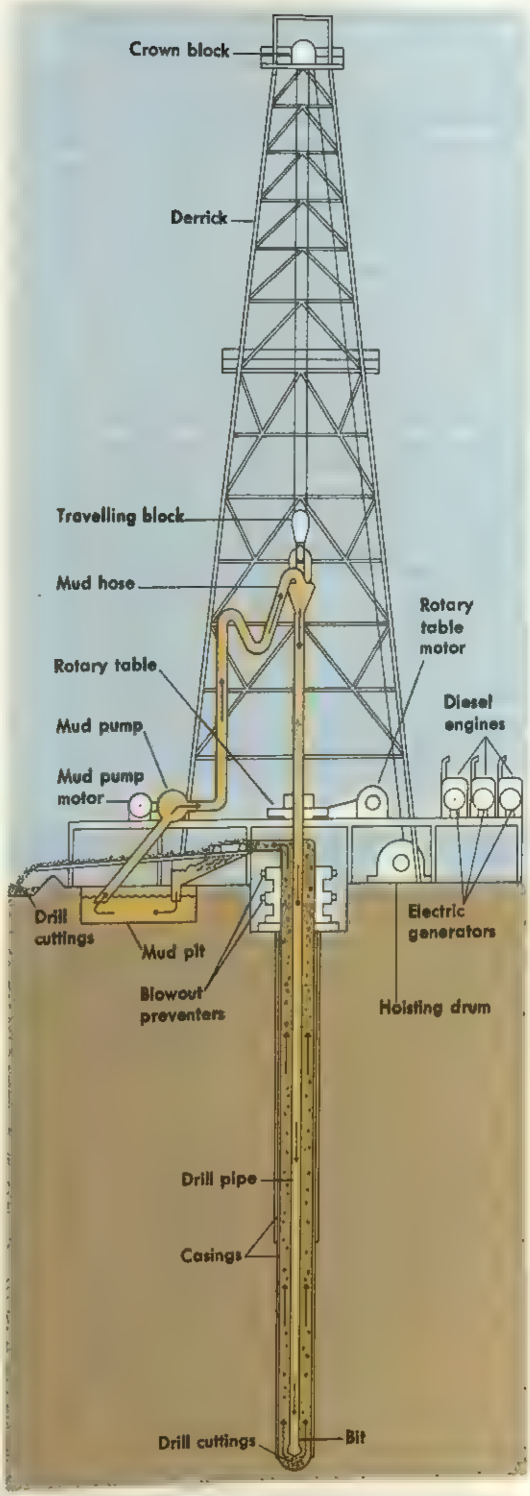
**Methods of drilling.** The first oil crews used a drilling technique called *cable-tool drilling,* which is still used for boring shallow holes in hard rock formations. Today, however, most crews use a faster and more accurate method called *rotary drilling.* On sites where the well must be drilled at an angle, crews use a technique called *directional drilling.* In addition, petroleum engineers are testing a variety of ways to increase the depth of oil wells and reduce the cost of drilling operations.

*Cable-tool drilling* is a simple process. It works much as a chisel is used to cut wood or stone. In this method, a steel cable repeatedly drops and raises a heavy cutting tool called a *bit.* Bits may be as long as 2.4 metres and have a diameter of 10 to 32 centimetres. Each time the bit drops, it drives deeper and deeper into the earth. The sharp edges of the bit break up the soil and rock into small particles. From time to time, the workers pull out the cable and drill bit and pour water into the hole. They then scoop up the water and particles at the bottom of the hole with a long steel pipe known as a *bailer.*

*Rotary drilling,* like cable-tool drilling, works on a simple principle. The drill bores through the ground much as a carpenter's drill bores through wood. The bit on a rotary drill is attached to the end of a series of connected pipes called the *drill pipe.* The drill pipe is rotated by a turntable on the floor of the derrick. The pipe is lowered into the ground. As the pipe turns, the bit bores through layers of soil and rock. The drilling crew attaches additional lengths of pipe as the hole becomes deeper. The drill pipe may be longer than 7,500 metres.

The drill pipe is lowered and raised by a hoisting mechanism called the *draw works,* which operates somewhat like a fishing rod. Steel cable is unwound from the *hoisting drum,* which is a kind of reel. The cable is then threaded through two *blocks* (sets of pulleys)—the *crown block,* at the top of the rig, and the *travelling block,* which hangs inside the derrick. The workers attach the upper end of the drill pipe to the travelling block with a giant hook. They can then lower the pipe into the hole or lift it out by turning the hoisting drum in one direction or the other.

During rotary drilling, a fluid called *drilling mud* is pumped down the drill pipe. It flows out of the openings in the bit and then back up between the pipe and the wall of the hole to just below the derrick floor. This constantly circulating fluid cools and cleans the bit and carries *cuttings* (pieces of soil and rock) to the surface. Thus, the crew can drill continuously without having to bail out the cuttings from the bottom of the well. The drilling mud also coats the sides of the hole, which helps prevent leaks and cave-ins. In addition, the pressure of the mud in the well reduces the risk of *blowouts* and *gushers,* which are caused by the sudden release of pressure in a reservoir. Blowouts and gushers may destroy the rig and waste much oil.




**A rotary-drilling rig** includes a derrick and the machinery that raises and lowers the drilling equipment. As the *drill pipe* is lowered, it is turned by a *rotary table.* The *bit* at the end of the drill pipe bores through the earth. Mud is pumped through the well to clean the bit and bring up *cuttings* (pieces of rock).

***Directional drilling.*** In cable-tool drilling and most rotary drilling, the well hole is drilled straight down from the derrick floor. In directional drilling, the hole is drilled at an angle. Drilling crews may use special devices called *turbodrills* and *electrodrills.* The motors that power these drills lie directly above the bit and rotate only the lower section of the drill pipe. Such drills enable drillers to guide the bit along a slanted path. Drillers may also use tools known as *whipstocks* to drill at an angle. A whipstock is a long steel wedge grooved like a shoehorn. The wedge is placed in the hole with the pointed end upward. The drilling path is slanted as the bit travels along the groove of the whipstock.

Many crews adopt directional drilling to drill more than one well at a site. The method is also used if a well cannot be drilled directly over a petroleum deposit.

***Experimental methods of drilling*** include the use of electricity, intense cold, and high-frequency sound waves. Each of these methods is designed to shatter the rocks at the bottom of the hole.

**Offshore drilling** is much more expensive and dangerous than drilling on land. The average offshore rig costs 10 times more than a land rig. All the equipment and the crew must be brought to the site by helicopter or ship. In such waters as the Arctic Ocean and the North Sea, rigs may be damaged by storms or floating blocks of ice. But as the number of land reserves declines, the importance of offshore wells increasingly outweighs their higher costs and risks.

Drilling an offshore well is similar to drilling a well on land. The parts of the drilling rig are the same. But an offshore rig must be mounted on something that can be taken to sea. Most exploratory wells are drilled from such movable rigs as *jack-up rigs, semisubmersible rigs,* or *drillships.* A structure called a *fixed platform* is used for oil production.

***Jack-up rigs*** are commonly used in water depths of up to about 60 metres. But some jack-up rigs can be used in depths of up to about 110 metres. The rig rests on a floating platform attached to steel legs that can be jacked up or down. To move the rig, workers lower the platform into the water and jack up the legs off the sea floor. Boats generally tow the rig to the new drilling site. There, the legs are again lowered to the sea floor, and the floating platform is jacked up clear of the water's surface.

***Semisubmersible rigs*** are used in intermediate water depths—that is, up to about 1,200 metres. This type of rig has legs filled with air, enabling it to float above the surface of the sea. Anchors hold the rig in place.

***Drillships*** are used in water depths of up to about 2,400 metres. Anchors cannot be used at such depths, so a drillship must use precise navigational procedures to maintain its position above the well site. The derrick and other drilling equipment are mounted on the deck, and the drill pipe is lowered through an opening in the bottom of the ship. Drillships are extremely expensive to operate.

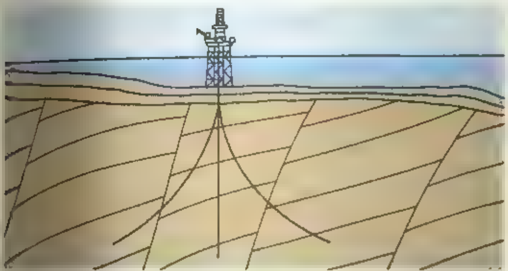
***Fixed platforms,*** also known as *production platforms,* are generally built and installed only after exploratory drilling has uncovered enough petroleum reserves to justify their enormous expense. Most fixed platforms are

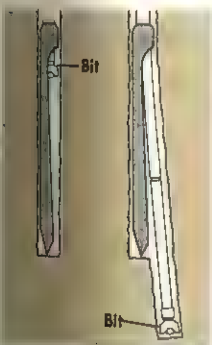
**Members of a drilling crew,** called *roughnecks,* prepare to change the bit. As the drill pipe is raised, the workers disconnect the lengths of pipe and stack them in the derrick.

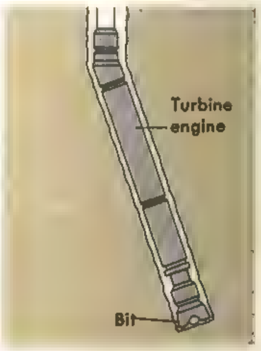
**The bit** is changed when it becomes dull or if a different type of bit is needed. A large-toothed bit, *above,* is used to drill through soft rock, such as limestone or sandstone.

### Directional drilling

In directional drilling, an oil well is drilled at an angle rather than straight down. Crews use such tools as *whipstocks* and *turbodrills* to guide the bit along a slanted path. This method is often used in offshore operations because many wells can be drilled directionally from one platform.






Whipstock

Turbodrill

used in shallow water, but some can be used in water deeper than 300 metres.

Fixed platforms are built in segments that are carried by barge to the production site. Cranes guide the bottom segment to the sea floor and position it over the site. Huge stakes called *piles* secure it to the sea floor. The second segment fits on top of the bottom segment. Most fixed platforms have two segments, but some have three. The top of the uppermost segment serves as the base for the drilling. As many as 42 wells can be drilled in various directions from a fixed platform.

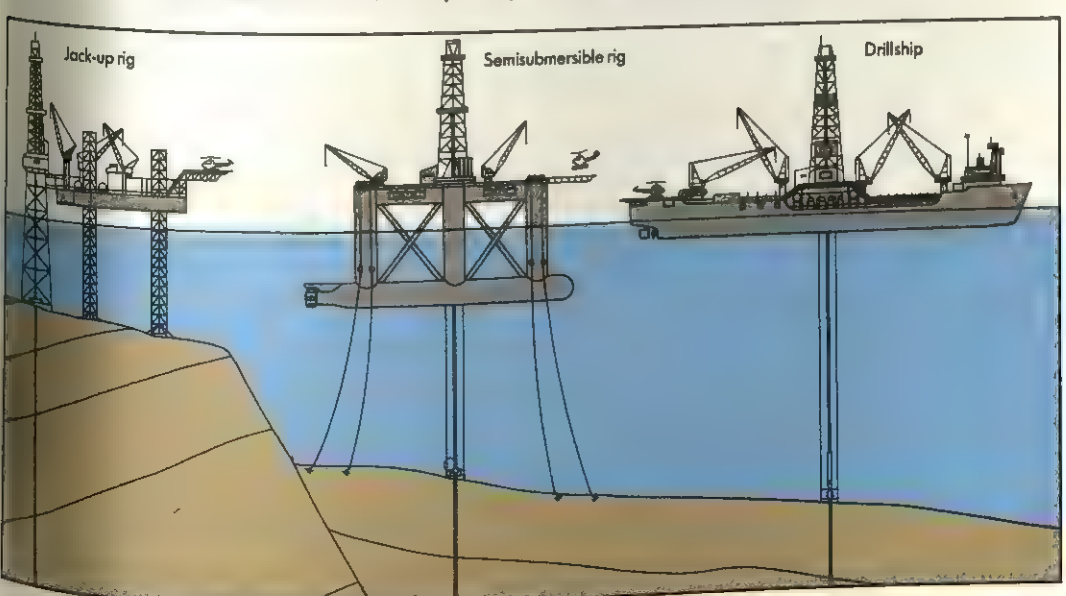
**Well testing.** Drilling crews try to determine as quickly as possible whether they are working on a productive site or a dry hole. During drilling, they continually examine the cuttings—the pieces of rock brought up by the drilling mud—for evidence of petroleum. When drilling reaches the depth of possible deposits, the crew may conduct several tests for oil. These tests include *coring, logging,* and *drill stem testing.*

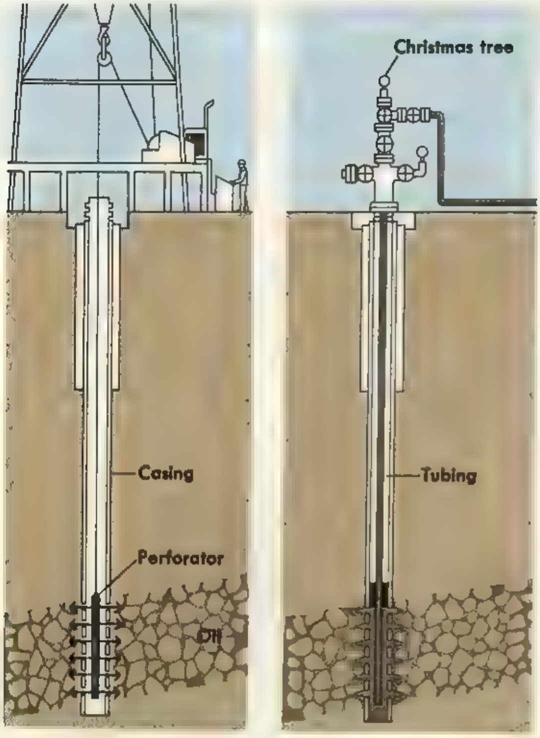
In coring, the drill bit is replaced with a *coring bit.* This bit cuts out a cylindrical sample of soil and rock, which is brought to the surface for analysis. Logging involves lowering measuring instruments called *sondes* into the well hole. They transmit information about the composition, porosity, fluid content, and other characteristics of the underground rock. In the drill stem test, a device that takes samples of fluids and measures their pressure is lowered into the hole.

If the test results are negative, the drilling crew may plug the well with cement and abandon it. If the tests show evidence of petroleum, the crew reinforces the well hole with steel pipe called *casing.*

**Casing** is a kind of protective lining for the well hole. It consists of heavy steel pipe that ranges in diameter from 7.2 to 50 centimetres. The lengths of pipe are held in place with cement. Casing helps prevent leaks and

**Offshore drilling** Most exploratory offshore wells are drilled from *jack-up rigs, semisubmersible rigs,* or *drillships.* A jack-up rig, which can be raised or lowered to various heights, has legs that rest on the sea floor. A semisubmersible rig floats on cylindrical legs filled with air. A drillship has drilling equipment mounted on its deck, and a special opening through which the drill pipe is lowered.






**Completing a well.** After lining the well hole with pipes called *casing,* the crew lowers an instrument called a *perforator* into the well. The perforator punches holes in the casing through which oil can enter, *left.* Then the crew installs the *tubing,* a string of smaller pipes that conducts the oil to the surface; and a *Christmas tree,* a set of valves that controls the flow of oil, *right.*

cave-ins during both the drilling stage and the production stage of the oil well. As an additional safeguard, nearly all drilling crews install one or more *blowout preventers* at the top of the casing. These devices consist of giant valves that close off the casing if pressure builds up in the well.

To install casing, drilling crews remove the drill pipe and lower the casing into the well hole. They then pump wet cement down the casing and cover the cement with a special plug that can be drilled through. While the cement is still wet, they pump mud into the casing. The mud pushes the plug down to the bottom of the casing. The cement is thus forced up into the space between the well hole and the outside of the casing from the bottom of the hole to the surface. After the cement hardens, workers can continue to drill through the plug.

**Completing the well** means bringing the well into production. This operation is carried out in several steps. First, the drilling crew lowers an instrument called a *perforator* into the casing to the depth of the oilbearing zone. The perforator fires special bullets or explosive charges into the casing, punching holes through which the oil can enter. The crew then installs the *tubing,* which is a string of smaller pipes that conducts oil to the surface. Tubing is used because the casing is generally too wide to maintain the fluid velocity necessary to keep the oil flowing upward. Tubing is also easier to repair and replace than casing.

One final step in completing a well is to assemble a group of control valves at the upper end of the casing and tubing. This valve system is known as a *Christmas tree* because of its many branchlike fittings. It controls the flow of oil to the surface. In some wells, more than one oilbearing zone is found. The crew then installs separate tubing and control valves for each of the oilbearing zones. Such operations are called *multiple completion wells.*

### Recovering petroleum

Petroleum is recovered in much the same way as underground water is obtained. Like certain types of water wells, some oil wells have sufficient natural energy to bring the fluid to the surface. Other oil wells have too little energy to produce oil efficiently, or they lose most of their energy after a period of production. In these wells, additional energy must be supplied by pumps or other artificial means. If natural pressure provides most of the energy, the recovery of petroleum is called *primary recovery.* If artificial means are used, the process is known as *enhanced recovery.*

**Primary recovery.** The natural energy used in recovering petroleum comes chiefly from gas and water in reservoir rocks. The gas may be dissolved in the oil or separated at the top of it in the form of a gas cap. Water, which is heavier than oil, collects below the petroleum. Depending on the source, the energy in the reservoir is called (1) solution-gas drive, (2) gas-cap drive, or (3) water drive.

Solution-gas drive brings only small amounts of oil to the surface. Most wells that have no natural energy other than solution-gas drive require supplementary forms of energy. Gas-cap drive and water drive, on the other hand, may result in the production of large quantities of petroleum.

***Solution-gas drive.*** The oil in nearly all reservoirs contains dissolved gas. The effect production has on this gas is similar to what happens when a bottle of champagne is opened. The gas expands and moves toward the opening, carrying some of the liquid with it.

***Gas-cap drive.*** In many reservoirs, gas is trapped in a cap above the oil as well as dissolved in it. As oil is produced from the reservoir, the gas cap expands and drives the oil toward the well.

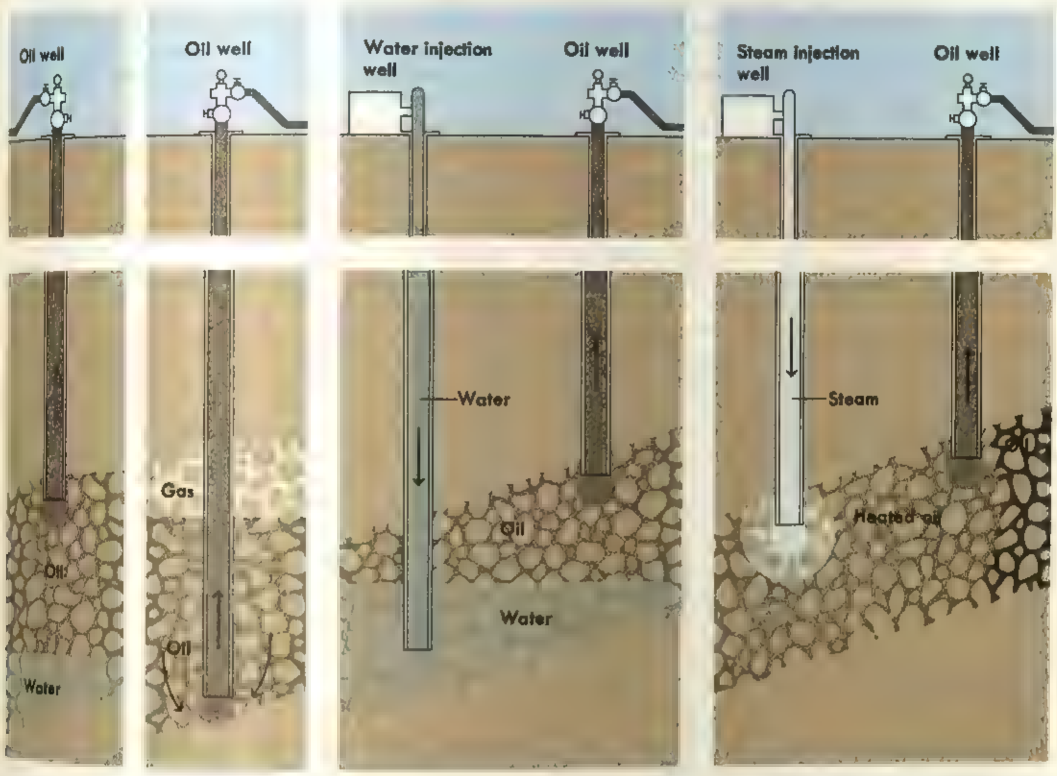
***Water drive.*** Like gas, water in a reservoir is held in place mainly by underground pressure. If the volume of water is sufficiently large, the reduction of pressure that occurs during oil production will cause the water to expand. The water will then displace the petroleum, forcing it to flow into the well.

**Enhanced recovery** includes a variety of methods designed to increase the amount of oil that flows into a producing well. Depending on the stage of production in which they are used, these methods are generally classified as either *secondary recovery* or *tertiary* (third-level) *recovery.*

Secondary recovery, also called *pressure maintenance,* consists of replacing the natural drives in the reservoir. This form of recovery may involve injecting gas or water into the reservoir from additional wells drilled near the producing well.

Although secondary recovery has nearly tripled the amount of recoverable oil, about two-thirds of the pe-

**How oil is recovered** A tremendous amount of energy is needed to bring oil to the surface. This energy may come from the natural pressure in a reservoir or from various artificial means. Depending on the source of energy, the process is called (1) primary recovery, (2) secondary recovery, or (3) tertiary recovery.




**Primary recovery** depends chiefly on two types of natural energy in a reservoir, *water drive* and *gas drive*. If oil production reduces some of the pressure underground, water or gas in the reservoir may drive the oil into the well.

**Secondary recovery** consists of replacing the natural energy in a reservoir. *Waterflooding*, one of the most widely used methods, involves injecting water into the reservoir. The water displaces the oil and causes it to flow into the well.

**Tertiary recovery** includes a number of experimental methods of bringing oil to the surface. In one such method, steam is injected into the reservoir. The steam heats the oil and makes it thinner, enabling it to flow more freely into the well.

troleum in most reservoirs remains below the surface after production. Petroleum engineers are testing techniques of tertiary recovery to bring more oil to the surface. One such technique uses heat to thin the oil and so make it flow more freely into the well. This heat may come from injections of steam or from burning some of the petroleum in the reservoir.

## Transporting petroleum

After crude oil reaches the surface, natural gas is separated from the oil. The gas is then sent to a processing plant or directly to consumers. Water and sediment are removed from the oil, which is then stored in tanks or sent to a refinery. From the refinery, petroleum products are delivered to markets.

Daily, millions of barrels of petroleum are transported from the production areas to the refineries. Petroleum is carried chiefly by pipeline, tanker, barge, tank truck, and railway tank wagon.

Most petroleum moves through pipelines for at least part of its journey. Pipelines transport crude oil from wells to storage tanks, to other carriers, or directly to refineries. Pipelines also carry petroleum products from refineries to markets. Some of the largest pipelines can carry more than a million barrels of oil daily. Pipelines can be built in almost any kind of terrain and climate. The Trans-Alaska Pipeline, for example, crosses 3 mountain ranges, more than 300 rivers and streams, and nearly 640 kilometres of frozen land. Pipelines cost a lot to build. But they are relatively cheap to operate and maintain and are generally the most efficient means of moving petroleum.

Tankers and barges transport oil on water. A tanker is a large oceangoing ship with compartments for liquid cargo. The largest tankers can hold more than a million barrels of petroleum. Barges, which can carry an average of 15,000 barrels of oil, are used mainly on rivers and canals.

Many petroleum products travel from refineries to markets by tank truck or railway tank wagon. Tank trucks deliver petrol to service stations and heating oil to houses. Such trucks can carry up to 300 barrels of fuel. Railway tank wagons range in capacity from about 100 to more than 1,500 barrels of oil. Some of these wagons have equipment to keep petroleum products at a certain temperature or level of pressure.

### Refining petroleum

Refineries range in size from small plants that process about 150 barrels of crude oil a day to giant complexes with a daily capacity of more than 600,000 barrels.

The basic job of a refinery is to convert petroleum into useful products. Refineries separate the oil into various hydrocarbon groups, or fractions. The fractions are then chemically changed and treated with other substances. These refining processes may be classified as (1) separation, (2) conversion, and (3) chemical treatment.

**Separation.** The first stage in petroleum refining is *fractional distillation,* which is a process that separates crude oil into some of its fractions. Additional fractions may be separated from these fractions by the processes of *solvent extraction* and *crystallization.*

***Fractional distillation*** is based on the principle that different fractions *vaporize* (boil) at different temperatures. For example, petrol vaporizes at about 24° C, but some of the heavy fuel oils have boiling points higher than 320° C. As vapours, such fractions also *condense* (cool and become liquid) at different temperatures.

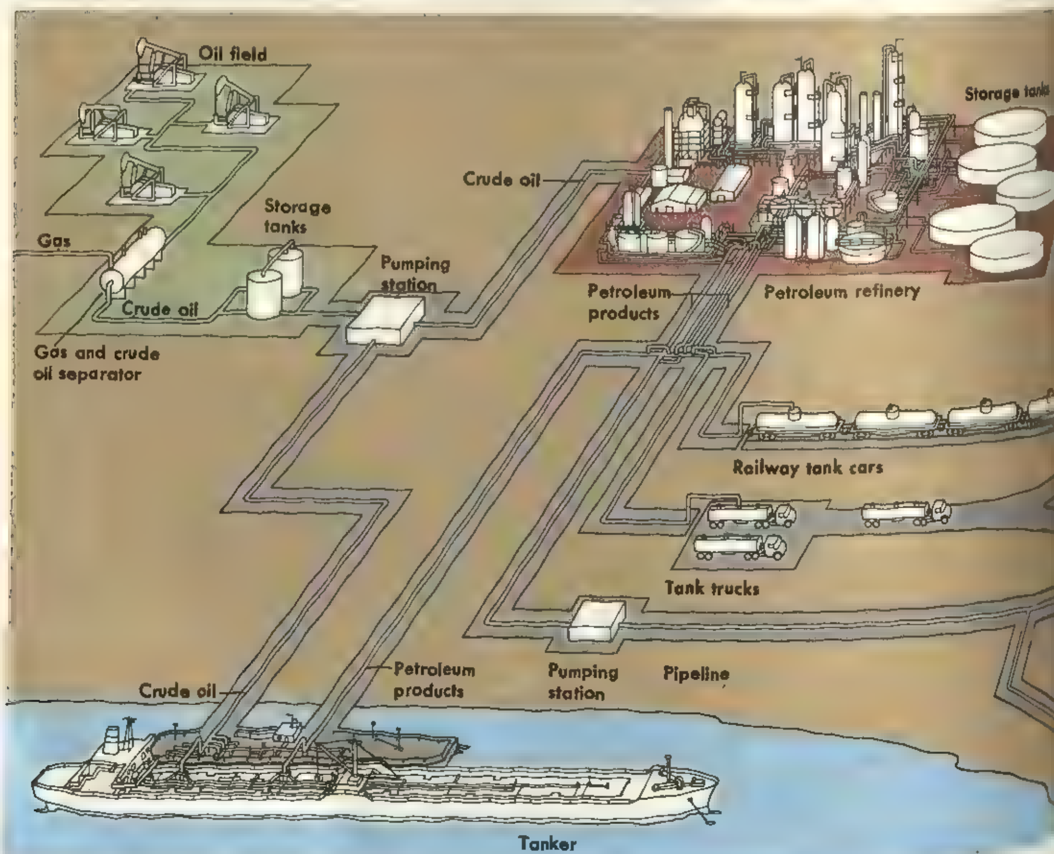
In fractional distillation, crude oil is pumped through pipes inside a furnace and heated to temperatures as high as 385° C. The resulting mixture of hot gases and liquids then passes into a vertical steel cylinder called a *fractionating tower* or a *bubble tower.* As the vaporized fractions rise in the tower, they condense at different levels. Heavy fuel oils condense in the lower section of the tower. Such light fractions as petrol and kerosene condense in the middle and upper sections. The liquids collect in trays and are drawn off by pipes along the sides of the tower.

Some fractions do not cool enough to condense. They pass out of the top of the fractionating tower into a *vapour recovery unit.* Other fractions, which vaporize at temperatures higher than those in the furnace, remain as liquids or semisolids. These *residues* are recovered from the bottom of the tower and refined into such products as asphalt and lubricating oils.

The fractions produced by distillation are called *straight-run products.* Almost all these products must undergo conversion and chemical treatment before they can be used.

***Solvent extraction*** separates additional fractions from certain straight-run products. A chemical called a *solvent* either dissolves some of the fractions or causes them to separate out as solids. The principal solvents

**How oil is transported** Petroleum is transported by a variety of methods during its journey from oil field to consumer. Nearly all oil moves through pipelines for at least part of the route. After crude oil is separated from natural gas, pipelines transport the oil to another carrier or directly to a refinery. Petroleum products travel from the refinery to market by tanker, tank truck, railway tank wagon, or pipeline.



used include *benzene, furfural,* and *phenol.* Many refineries improve the quality of paraffin and lubricating oils by solvent extraction.

*Crystallization* is used chiefly to remove wax and other semisolid substances from heavy fractions. The fractions are cooled to a temperature at which they form crystals or solidify. They are then put through a filter that separates out the solid particles.

**Conversion.** Although nearly all petroleum can be refined into useful products, some fractions have much more value than others. Petrol, for example, accounts for almost half the petroleum products used in most countries. But it makes up only about 10 per cent of the straight-run products. On the other hand, some fractions that are in less demand than petrol make up a higher percentage of crude oil.

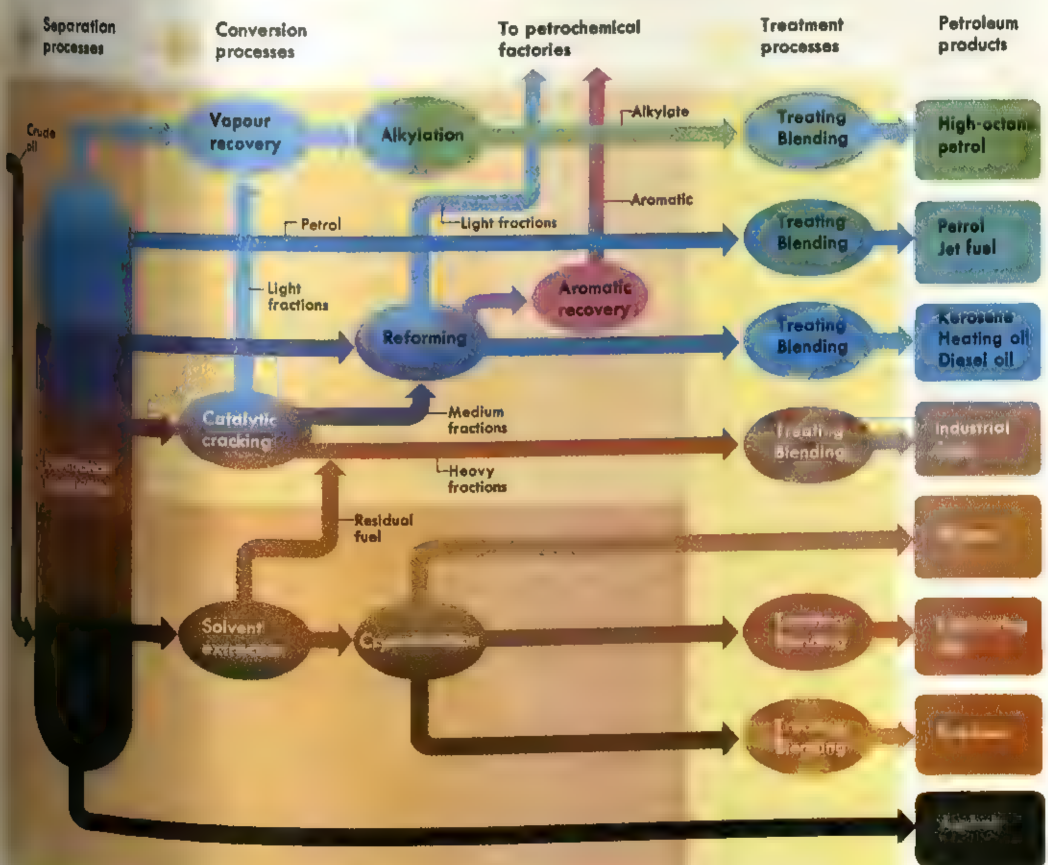
To increase the yield of desirable products from petroleum, scientists have developed several methods to convert less useful fractions into those that are in greater demand. These methods fall into two main groups: (1) cracking processes and (2) combining processes. Such conversion processes allow refiners to produce about half a barrel of petrol from each barrel of crude oil.

***Cracking processes*** convert heavy fractions into lighter ones, mainly petrol. These processes not only increase the quantity of petrol obtained from oil but also improve its quality. Petrol produced by cracking has a higher *octane number* than the straight-run product. Octane number is a measure of how smoothly fuel burns in an engine. See **Octane number**.

There are two principal types of cracking processes—*thermal cracking* and *catalytic cracking.* In thermal cracking, heavy fractions are subjected to intense heat and pressure in order to weaken the bonds that hold large, complex molecules together. The heat and pressure *crack* (break down) these molecules into the simpler ones that make up light fractions.

In catalytic cracking, a *catalyst* is used to accelerate the thermal cracking process. A catalyst is a substance that sets off or speeds up a chemical reaction without being changed by the reaction. In this form of cracking, the fractions are heated and then passed over minerals called *zeolites,* certain types of clay, or other catalysts.

**How oil is refined** Refineries convert crude oil into useful products in three basic stages. The first stage, called *separation,* consists of separating the oil into its various *fractions* (parts). The main process in this stage is *fractional distillation,* which separates light, medium, and heavy fractions. In *conversion,* the second stage, less useful fractions are converted into more valuable ones. The third stage is *treatment,* which improves the quality and performance of petroleum products.



The combination of heat and catalytic action causes the heavy fractions to crack into lighter ones. Catalytic cracking is more widely used than thermal cracking because it requires less pressure and produces higher-octane petrol.

During cracking, hydrogen may be added to the fractions. This procedure, known as *hydrogenation,* further increases the yield of useful products.

*Combining processes* do the reverse of cracking. They combine or rearrange simple gaseous hydrocarbons to form more complex fractions. As a result, many of the gases produced by distillation and cracking are converted into high-octane liquid fuels and valuable chemicals. The major combining processes include *polymerization, alkylation,* and *reforming.*

In polymerization, gases are subjected to heat and pressure in the presence of a catalyst. The hydrocarbon molecules unite and form larger molecules known as *polymers.* Polymers are essential ingredients in high-octane petrol. Alkylation is similar to polymerization. It produces a fraction called *alkylate,* which is used in both aviation fuel and petrol. In reforming, the molecules in gases form different hydrocarbon groups after exposure to heat and a catalyst. Reforming produces high-octane fuels and *aromatics,* which are chemicals used in making explosives, synthetic rubber, food preservatives, and many other products.

**Chemical treatment.** Nearly all fractions are chemically treated before they are sent to consumers. The method of treatment depends on the type of crude oil and on the intended use of the petroleum product.

Many fractions are treated to remove impurities. The most common impurities are sulphur compounds, which can damage machinery and pollute the air when burned. Treatment with hydrogen is a widely used method of removing sulphur compounds. In this method, fractions are mixed with hydrogen, heated, and then exposed to a catalyst. The sulphur in the fractions combines with the hydrogen, forming hydrogen sulphide. The hydrogen sulphide is later removed by a solvent.

Some fractions perform better if they are blended or combined with other substances. For example, refineries blend various lubricating oils to obtain different degrees of *viscosity* (thickness). Petrol is blended with chemicals called *additives,* which help it burn more smoothly and give it other special properties.

### The petroleum industry

The petroleum industry is one of the world's largest industries. It has four major branches. The *production branch* explores for oil and brings it to the surface. The *transportation branch* sends crude oil to refineries and delivers the refined products to consumers. The *manufacturing branch* processes crude oil into useful products. The *marketing branch* sells and distributes the products to consumers. Petrol service stations handle the largest share of these sales. Oil companies sell their petroleum products directly to factories, power plants, and transportation-related industries.

The petroleum industry plays a large role in the economy of many nations. In many industrial countries, it provides jobs for a great many people. It also is a major buyer of iron, steel, motor vehicles, and many other products. In certain developing but oil-rich countries, petroleum exports furnish most of the national income. Petroleum is also a source of political power for such countries because many other nations depend on them for fuel.

During the early 1900's, many oil companies began to develop the petroleum industry in various countries in the Middle East, Africa, and other parts of the world. These firms, most of which were American or European, received ownership of the oil they discovered and produced. In return, they paid the host countries taxes and a share of the income from oil sales. Beginning in the 1950's, however, more and more host countries came to feel that they were not receiving a large enough share of the oil income. Today, many of these countries have acquired part or total control of the oil industry within their borders, either by negotiating with the foreign firms or by taking them over. In addition, a number of the countries belong to a powerful association called the Organization of Petroleum Exporting Countries (OPEC).

OPEC, which was formed in 1960, consists of 13 nations that depend heavily on oil exports for their income. These nations include Libya, Nigeria, Venezuela, and the major oil-producing countries of the Middle East. OPEC members provide about 45 per cent of all oil exports. Thus, the amount they produce and the prices they agree to charge largely determine the cost of petroleum.

Industrial countries are so dependent on imported oil that OPEC can use oil as an economic and political weapon. In the 1970's, OPEC raised oil prices so drastically that its members were able to increase their income from oil while restricting production.

In the United States, the petroleum industry ranks as one of the largest private employers. The industry includes about 45,000 companies, most of which are small firms that specialize in one branch of the industry. The larger companies are active in all branches. There are nearly 200,000 petrol service stations, most of which are independently owned and operated.

The United States is one of the world's leading producers and refiners of petroleum. More than $2\frac{1}{2}$ billion barrels of crude oil are produced by U.S. wells annually. About $5\frac{1}{2}$ billion barrels of petroleum annually, or about a quarter of the world total, are processed by U.S. refineries. The United States is also the world's largest consumer of petroleum. In spite of the size of the U.S. oil industry, the nation's demand for petroleum products far exceeds domestic production. As a result, the country imports about 55 per cent of the oil it uses.

In the United Kingdom (UK), the oil industry is an important industry. Oil was first discovered in the UK sector of the North Sea in 1969. Production of North Sea oil started in 1975. The UK turned from being totally dependent on imported oil to become a major oil producer. The boom in oil exploration and production led to an increase in output for many engineering, shipbuilding, and other firms that helped to build, equip, and service the oil installations.

In Australia and New Zealand, the petroleum industry is extremely important. Australia fulfils more than half its energy requirements with petroleum fuels. It used to rely almost completely on imported petroleum. Today,

the country produces enough oil to meet almost all of its oil needs and all of its natural gas needs. It continues to import heavy crude oil from the Middle East because Australian oils are light oils.

Australia has the highest rate of consumption of refined petroleum products in Australasia. Consumption, which includes fuel for international shipping and for the refineries themselves, amounts to more than 190 million barrels a year. Petrol used to power motor vehicles makes up 40 per cent of this total. The other major petroleum products used are fuel oil, diesel oil, aviation fuel, kerosene, *bitumen* (natural tar), lubricating oil, and industrial fuel oil.

New Zealand produces enough oil to meet about 20 per cent of its liquid fuel requirements, mainly in the form of *condensates* (condensed gas). It also produces natural gas. Much of its gas production provides fuel for cars. It also imports and refines crude oil.

New Zealand uses about 32 million barrels of petroleum products a year. More than half the total is in the form of petrol. Diesel, jet, and furnace fuels account for about two-fifths of the petroleum products consumed.

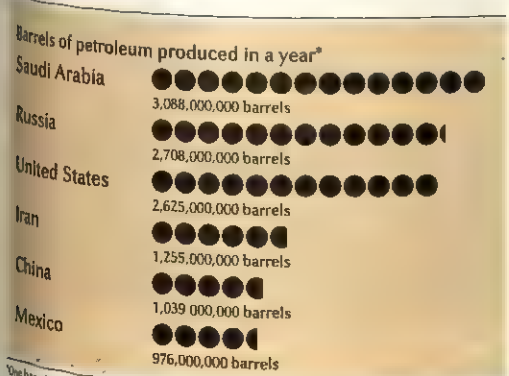
### Petroleum conservation

The world's supply of oil is limited and will eventually run out. Some experts predict that if oil consumption continues to rise, existing petroleum reserves will be exhausted by the mid-2000's. Conservation of oil has thus become urgent for all nations, but particularly for those that use the most energy.

**Conservation by the oil industry.** The oil industry itself has developed a number of methods of conservation. Most of them are classed as either (1) oil-field conservation or (2) refinery conservation.

***Oil-field conservation*** consists chiefly of methods to increase the amount of petroleum recovered. One of the most widely used measures of oil-field conservation is a pooling system called *unitization*. Under this system, two or more oil companies working in the same field agree to operate as a unit. Unitization enables the companies to make the most efficient use of natural and artificial energy in recovering oil.

**Leading petroleum-producing countries**




*One barrel equals 159 litres.
Figures are for 1992. Source: U.S. Energy Information Administration.

***Refinery conservation*** is aimed mainly at reducing the amount of heat energy used in refining. Most refineries have devices called *heat exchangers*, which recycle excess heat from such processes as fractional distillation and thermal cracking. New catalysts are being developed to lower the energy requirements of the chemical reactions. Many plants use computers to maintain furnaces and heaters at the most efficient temperatures. Heat energy is also conserved by insulating pipes, tanks, and other refinery equipment.

**Conservation by consumers.** Some of the most extensive conservation programmes have been adopted by commercial consumers of petroleum. Many manufacturers have installed equipment to store energy and reduce fuel consumption in their plants. Such materials as aluminium and paper are reused in some factories because recycling waste products requires less energy than manufacturing new products.

Certain conservation measures originally adopted by some businesses and factories are now legally enforced in some countries. In the United States, for example, temperatures in most work areas must not be cooled below 26 °C in summer nor heated above 18 °C in winter.

In the home, common sense is often the best guide to saving energy. In cold months, for example, people can take advantage of solar energy simply by opening their curtains during the day. They can further reduce fuel consumption by closing the curtains at night and by turning off the heat in rooms that are not being used. Homeowners who live in cold climates can conserve heat by installing double-glazed windows, draught proofing, and other forms of insulation.

Most consumers can also conserve fuel that they use outside the home. By keeping cars well tuned and by driving within speed limits, motorists can minimize petrol consumption. They can save even more fuel by purchasing fuel-efficient cars, forming car pools, or switching to public transportation.

### History of the use of petroleum

People have used petroleum for thousands of years. The Bible mentions that Noah used a solid form of petroleum called *pitch* in building the ark. The ancient Egyptians coated mummies with pitch. About 600 B.C., King Nebuchadnezzar II used pitch to build the walls and pave the streets of Babylon.

In America, the Indians used crude oil for fuel and medicine hundreds of years before the first white settlers arrived. In the early 1600's, missionaries travelling through what is now Pennsylvania found Indians scooping up oil from surface pools. The remains of wells in the Eastern United States indicate that the Indians also obtained oil from underground deposits.

By 1750, the American colonists had found many oil seepages in New York, Pennsylvania, and what is now West Virginia. Some wells that were dug for salt produced oil. Salt makers regarded the oil as a nuisance, but other people found uses for it. About 1857, Samuel M. Kier, a Pittsburgh pharmacist, promoted oil as a cure for many ailments. The frontiersman Kit Carson sold oil as axle grease to pioneers.

A major breakthrough in the use of petroleum occurred in the 1840's, when a Canadian geologist named

Abraham Gesner discovered *kerosene* (paraffin). This fuel could be distilled from coal or oil. Paraffin became widely used in lamps, and oil quickly rose in value.

**Beginnings of the oil industry.** Most historians trace the start of the oil industry on a large scale to 1859. That year, a retired railway guard named Edwin L. Drake drilled a well near Titusville, Pennsylvania, U.S.A. Drake used an old steam engine to power the drill. After Drake's well began to produce oil, other prospectors drilled wells nearby. Within three years, so much oil was being produced in the area that the price of a barrel dropped from 20 U.S. dollars to 10 cents.

By the early 1860's, the oil boom had transformed western Pennsylvania. Forests of wooden derricks covered the hills, and thousands of prospectors crowded into the new boom towns. At first, wagons and river barges carried the oil to refineries on the Atlantic Coast. But the growing volume of oil soon required more efficient means of transportation. Railways established branch lines to the fields and began to haul oil. In 1865, the first successful oil pipeline was built from an oil field near Titusville to a railway station 8 kilometres away. Within 10 years, a 97-kilometre line ran from the oil region to Pittsburgh.

Prospectors discovered that other states had even larger oil deposits than Pennsylvania. By the 1880's, commercial production of oil had begun in Kentucky, Ohio, Illinois, and Indiana. In 1901, the opening of the Spindletop field in eastern Texas produced the first true gusher in North America. During the 1890's and early 1900's, California and Oklahoma joined Texas as the leading oil-producing states. Annual oil production in the United States rose from 2,000 barrels in 1859 to 64 million barrels in 1900.

Commercial oil production spread rapidly throughout the world. Italy began to produce oil in 1860. After Italy, production began, in order, in Canada, Poland, Peru, Germany, Russia, Venezuela, India, Indonesia, Japan, Trinidad, Mexico, and Argentina. The first important oil discoveries in the Middle East occurred in Iran in 1908. Prospectors struck oil in Iraq in 1927 and in Saudi Arabia in 1938. Huge oil fields were later found in other states on the Persian Gulf.

**Growth of the oil industry.** During the 1800's, paraffin had been the chief product of the petroleum industry. Refiners considered petrol a useless by-product and often dumped it into creeks and rivers. Then, about 1900, two events dramatically changed the situation—electric lights began to replace paraffin lamps, and the motorcar rolled onto the scene. The demand for paraffin thus declined just as an enormous market for petrol opened up.

At that time, however, 100 barrels of crude oil produced only about 11 barrels of petrol. As a result, petroleum refiners looked for ways to increase the output of petrol without creating a surplus of other less profitable products. The introduction of the thermal-cracking process in 1913 helped solve the problem. Within five years, refiners had more than doubled the amount of petrol that they could produce from a single barrel of crude oil.

World War I (1914-1918) created a tremendous demand for petroleum fuels to power tanks, ships, and aeroplanes. Fuels became as important to the war effort as ammunition. After the war, the use of petroleum brought about big changes on farms. More and more farmers began to operate tractors and other equipment powered by oil. Agricultural productivity increased greatly as a result. In addition, in many countries petrol taxes provided the money and asphalt furnished the raw material to build roads in rural areas. Farmers thereby gained better access to markets.

During World War II (1939-1945), the American oil industry increased production and developed specialized products quickly. Huge quantities of oil were produced and converted into fuels and lubricants. Such new refining processes as catalytic cracking and alkylation vastly increased the output of high-octane aviation fuel. The United States supplied over 80 per cent of the aviation fuel used by the Allies during the war. American refineries also manufactured *butadiene*, used in making synthetic rubber; *toluene*, an ingredient in TNT; medicinal oils to treat the wounded; and other military needs.

**Postwar developments.** The demand for petroleum products became even greater after World War II. By the early 1950's, petroleum had replaced coal as the chief fuel in many countries. Some of the petroleum technology perfected during the war became the basis for peacetime industry. The petrochemical industry, for example, grew enormously as a result of the manufacture of synthetic rubber.

The petroleum industry in many Middle Eastern countries was owned or operated by American or Euro-

**The first gusher** in North America blew in at the Spindletop field near Beaumont, Texas in 1901. It sprayed more than 800,000 barrels of oil into the air until it was brought under control.

pean companies. In 1951, Iran became the first country to take over the holdings of such firms. By the mid-1970's, most nations in the Middle East either fully controlled or held a majority interest in their petroleum industry.

**Recent developments.** The ever-increasing use of petroleum products, especially in industrialized countries, has helped raise the living standards of many people. But it has also resulted in some serious problems, which include (1) the energy shortage, (2) the rising cost of oil, and (3) environmental pollution.

*The energy shortage.* Discoveries of oil in northern Alaska, U.S.A., and under the North Sea during the late 1960's added more than 30 billion barrels to world reserves. But these gains were offset by rising levels of consumption, particularly among industrialized nations. During the 1970's, the United States, Japan, and most countries in Western Europe increased their oil imports.

At the same time, political instability in the Middle East disrupted the flow of oil. During the Arab-Israeli wars of 1967 and 1973, the Arabs cut off or reduced petroleum exports to Japan and some Western nations. Many nations that depended on imported oil began energy conservation schemes. Some countries, such as Belgium, France, and Sweden, also developed nuclear energy programmes to reduce further their dependence on imported oil. For a time, oil consumption declined. But concerns about conserving energy lessened in the mid-1980's, partly because of falling oil prices.

*The cost of oil.* In the 1970's, the 13 member countries of OPEC increased their oil prices tremendously. The cost of a barrel of crude oil jumped from about 2.75 U.S. dollars in 1973 to a peak of 34 U.S. dollars in 1981. OPEC price increases severely strained the economies of many countries and worsened inflation throughout the world. Some poorer nations had to borrow heavily to pay for their petroleum imports. But the increase in oil prices spurred companies in the United States, Great Britain, and other countries to begin oil production in areas where it had previously been unprofitable.

Oil prices fell after 1981 as a result of increased production and reduced consumption. In 1986, the average price of crude oil reached a low of 12.50 U.S. dollars a barrel in the United States. Oil consumption began to rise after prices fell. OPEC members and some other producers cut oil production in the late 1980's to drive up prices. Oil prices then began to rise slowly.

*Environmental pollution.* The production, transportation, and use of petroleum have created serious environmental pollution problems. Tankers and offshore drilling accidents can cause oil spills that pollute the water, damage beaches, and destroy wildlife. Some people fear that hot oil flowing through the Trans-Alaska Pipeline upsets the ecological balance of the Arctic environment. Fuels burned by motor vehicles, power plants, and factories are a major source of air pollution.

Many laws have been passed in the United States, Canada, and other countries to control environmental pollution. The petroleum industry itself has invested heavily in the development of techniques and products to minimize pollution. To reduce the pollutants in motor vehicle exhaust, for example, oil companies cooperated with car manufacturers in the production of unleaded petrol.

**The future of the petroleum industry.** Most experts predict that the worldwide demand for petroleum will continue to increase in the years ahead. They also predict that the world's dependence on oil from the Middle East will increase. In addition, many experts believe that oil will become scarce sometime in the mid-2000's unless large new deposits are found.

The only long-range solution to the energy crisis is the introduction of alternative sources of fuel. Scientists have developed techniques to convert coal into oil and gas, and to produce oil from bituminous sands and oil shale. These synthetic fuels are still too expensive to produce commercially on a large scale. But if oil prices continue to increase, such fuels eventually may be able to compete in cost with petroleum.

It will probably be many years before alternative fuel sources make a major contribution to the world's energy supply. Until then, oil companies and oil consumers will need to conserve existing reserves by using energy as efficiently and sparingly as possible.

**Related articles** in *World Book.* See the *Economy* section of the articles on the various states, provinces, and countries mentioned in the *Where petroleum is found* section of this article. See also:

**Products**

| | | |
|---|---|---|
| Asphalt | Microcrystalline wax | Paraffin wax |
| Benzine | Mineral oil | Petrochemicals |
| Butane and propane | Napalm | Petrol |
| Fuel | Naphtha | Petrolatum |
| Gas (fuel) | Paraffin | Petroleum coke |
| Kerosene | | Plastics |

**Other related articles**

| | |
|---|---|
| Bituminous sands | Octane number |
| Conservation | Oil shale |
| Distillation | Organization of Petroleum Exporting Countries |
| Energy supply | Pipeline |
| Environmental pollution | Rock |
| Hydrocarbon | Royal Dutch/Shell Group |
| Hydrogenation | Standard Oil Company |
| International Energy Agency | Synthetic fuels |
| Magnetometer | |

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- B. Petroleum as a raw material
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**Questions**

How can consumers conserve petroleum?
How much oil can be recovered from most deposits?
What does petroleum consist of?
How do most scientists think oil and gas were formed?
What part did the car play in the development of the petroleum industry?
Why do oil crews sometimes inject water or gas into a producing well?
Which area of the world has the most oil?
Why is drilling for oil usually an enormous gamble?
Why is offshore drilling for oil more expensive and dangerous than drilling on land?
What is OPEC?

**Petroleum coke** is a useful product obtained in refining crude oil. The production of petroleum coke begins after all the petrol, paraffin, gas oils, lubricating oils, and other products have been distilled from crude oil. Pumps then force the heavy *residual oil* that remains through tubes of a furnace. There, the oil is heated to a high temperature. The heated oil then stews in *coking drums* until it becomes solid coke.

Petroleum coke has many uses in industry. For example, it is used in making carbon or graphite electrodes for torch batteries and dry cells. Coke is also important in the refining of various metals and in the production of abrasives and heat-resisting materials. It is used in producing synthetic graphite for nuclear reactors. Carbon made from petroleum coke is widely used in the chemical industry because of its resistance to corrosion by chemicals.

**Petroleum engineering.** See **Engineering** (Other specialized fields).

**Petroleum jelly.** See **Petrolatum.**

**Petroleum wax.** See **Wax** (Mineral wax).

**Petrology** is a branch of geology that deals with the origin and composition of rocks. Petrologists analyse the physical and chemical conditions involved in the formation of the three major types of rocks: *igneous, metamorphic,* and *sedimentary* (see **Rock**). Such analysis helps provide clues to the origin and development of the earth.

Petrologists work both in the field and in the laboratory. They study the location, position, and distribution of rocks in nature. They use microscopic and chemical techniques to determine the minerals that make up individual rocks. In addition, petrologists attempt to reproduce in a laboratory the temperature and pressure that affect rock formations. These experiments provide data about the physical and chemical properties of rocks under varying conditions.

See also **Earth** (History); **Geology** (table).

**Petronius** ( ? -A.D. 66) wrote the first Roman novel, the *Satyricon.* Only sections of the novel exist today. The work traces the adventures of three Romans as they travel in Italy. Through a mixture of prose and poetry, Petronius portrayed conditions of real life under the Roman emperor Nero. He described a society filled with dishonesty, insincerity, and vice. Nearly one-third of the surviving novel deals with a rich but uneducated man called Trimalchio and a lavish dinner party he gave. During the dinner, Trimalchio attempts to impress his guests with what he thinks is good taste. But the host's showiness and vulgarity expose his cultural inferiority to his intellectually superior guests. Scholars believe Petronius wrote the novel to ridicule Roman society under Nero.

**Petrov Affair,** named after Vladimir Petrov ( ? -1991), aroused bitter controversy in Australia. It began in 1954, when Prime Minister Robert Menzies announced that Petrov, an official at the Soviet embassy in Canberra, Victoria, had asked for political asylum in Australia. Menzies stated that Petrov had disclosed the existence of a Soviet spy ring in the country.

Soviet officials declared that Petrov had stolen embassy funds. They tried to escort his wife, Evdokia Alexeyevna Petrov, back to the Soviet Union. But she asked for asylum during the journey. Australian police released her at Darwin in the Northern Territory. The Soviet Union broke off diplomatic relations with Australia until 1959. In 1956, Petrov and his wife became naturalized Australian citizens.

The government appointed a royal commission to investigate the affair. In 1955, the commission reported its findings that spies had been operating in Australia. The report did not implicate any Australians.

Labor Party leaders, including H. V. Evatt, accused the government of staging the Petrov Affair in order to boost its popularity just before an election. The affair exposed deep divisions within the Labor Party over its attitude toward communism. Anticommunist Labor Party members accused Evatt of being pro-communist. The party's federal executive supported him and expelled the anticommunist members from the party.

See also **Evatt, Herbert Vere; Australia, History of.**

**Petunia** is any of a group of herbs native chiefly to Argentina and Brazil. They are widely cultivated in other countries as annual garden flowers. The petunia plant is covered with tiny hairs. Gardeners value the petunia

**Petunias** have large, colourful, funnel-shaped flowers. The plants are widely grown in gardens and window boxes.

for its beautiful funnel-shaped flowers, which are large and velvety. Some varieties have a single series of petals, and others have a double series.

Most petunias are *perennials* (plants that live for more than two years without replanting), but they are usually grown as annuals because they flower during their first year. Petunias may be grown from cuttings or from seeds. They thrive in a sunny location. They are popular plants for window boxes and hanging baskets.

**Scientific classification.** Petunias belong to the nightshade family, Solanaceae. They make up the genus *Petunia.* Cultivated petunias are *P. × hybrida.*

See also **Painted-tongue.**

**Pevsner, Antoine** (1886-1962), was a Russian-born painter and sculptor. He was influenced by the cubist painters and sculptor Alexander Archipenko, whom he met in Paris in 1911. Pevsner settled in Paris in 1923 and then became a French citizen.

Pevsner painted until 1923, when he turned to sculpture. One of Pevsner's best-known early works is a 1926 portrait of artist Marcel Duchamp made of blades of metal and transparent plastic. In his later work, Pevsner formed bronze, brass, and copper constructions with deep hollows that unite light and space. Two of his best-known works are *Construction in the Egg* (1948) and *Peace Column* (1954). Pevsner was born in Orël, Russia. Pevsner's brother was sculptor Naum Gabo (see **Gabo, Naum**).

**Pevsner, Sir Nikolaus** (1902-1983), a German-born author and scholar, became well known for his series of books, *The Buildings of England,* published between 1951 and 1974. His other publications include *The Sources of Modern Architecture and Design* (1968).

Pevsner was born in Leipzig. He studied the history of art and architecture and became a university lecturer. In 1934, he left Germany for England. After 1949, he held professorships at Cambridge and Oxford universities, and at Birkbeck College, London University. Pevsner was knighted in 1969.

**Pewee.** See **Wood pewee.**

**Pewter** is an alloy that consists mainly of tin. It also contains antimony and copper. Pewter has a metallic, white colour much like that of silver and a finish that can vary from dull to highly polished. It is widely used in making such articles as bowls, candlesticks, and tea services. Pewter is a soft alloy and dents easily. Articles made of pewter require care in handling.

Pewter consists of at least 90 per cent tin, a very soft metal. From 2 to 8 per cent antimony and up to 3 per cent copper are added to harden and strengthen pewter. At one time, most pewter also contained lead. But lead caused tarnishing. It also could dissolve in some foods and beverages served in pewter ware, forming toxic substances. During the mid-1700's, a nonlead pewter called *Britannia metal* came into use in England. It consisted of tin, antimony, and copper and did not tarnish. Today, Britannia metal and pewter are both used to make pewter articles.

**How pewter is made.** The first step in making pewter is to melt the tin in a pot called a *crucible.* Next, antimony and copper are dissolved in the liquid tin. Once mixed thoroughly, the alloy is poured into metal, plaster, or wooden forms to cast the desired articles.

Pewter can also be poured into iron moulds and then rolled and cut into standard shapes. Such shapes include discs, rectangular sheets, and wires, which craftworkers form into various objects. Pewter discs are shaped by a process called *spinning.* Spinning consists of holding the disc against a steel or wooden form turned by a machine called a *lathe.* Craftworkers use blunt tools to push the pewter into the shape of the spinning form. Pewter sheets are shaped into various items by hammering the metal with a leather, metal, plastic, or wooden mallet. Craftworkers use pewter

Brass and bronze sculpture 52.7 centimetres high; The Museum of Modern Art, New York City

**Antoine Pevsner's *Developable Column*** shows how he tried to enclose space through a complex series of hollows.

**Pewter** is an alloy that has a white, metallic colour resembling silver. Pewter is used to make bowls and tea services.

wires as decorative trim for pewter articles. The parts of many pewter items are joined by a process called *soldering* (see **Solder**).

**Caring for pewter.** Pewter, if given proper care, does not tarnish or require polishing. It should be washed in hot, soapy water as soon as possible after being used. Pewter should be rinsed in clear hot water and dried immediately with a soft cloth. Pewter articles should not be left to dry in the air. Air drying sometimes leaves water spots, which are difficult to remove. Pewter should never be washed in a dishwasher because the heat of the drying cycle can darken the surface.

Pewter serving pieces should not be used in preparing food. Pewter has a melting point between 244 and 295 °C, and so it can melt if placed on a burner.

**History.** During the 1600s and 1700s, people in England and the rest of Europe used pewter extensively for household utensils, and to some extent for church vessels. Craftworkers introduced pewter as a cheaper, but less satisfactory, alternative for silver and gold. Pewter became popular with people who could not afford the expensive metals. Many articles made of pewter are obvious copies of the work of goldsmiths and silversmiths. This happened because pewter craftworkers, like those working in precious metals, followed the general fashions of the times. Pewterers did not attempt to copy the more elaborate pieces especially adapted to finer metals. They wisely chose the simple, finely worked, unornamented pieces with designs particularly adapted to pewter. After 1800, china and glassware gradually replaced pewter.

Today, most antique pewter is in museums or private collections. Such pewter may contain lead, and so it should not be used for serving food. Making objects out of pewter is a popular craft in home and school workshops.

**Peyote.** See **Mescaline.**

**pH** is a number used by scientists to indicate the concentration of hydrogen ions in a solution. pH generally ranges from 0 to 14. At 25 °C, a pH below 7 indicates that a solution is acidic, and a pH above 7 indicates that a solution is *basic* (alkaline). A neutral solution, such as pure water, is neither acidic nor basic and has a pH of 7. Human blood has a pH of about 7.4. The letters *pH* stand for *potential of hydrogen.*

The Danish biochemist Søren Sørensen invented the pH system in 1909. A solution's pH is defined as the negative logarithm, to the base 10, of its hydrogen-ion concentration. This concentration is expressed in *moles* of hydrogen ions per litre of solution (see **Mole**). A solution with a pH of 6 contains $10^{-6}$ (one millionth) of a mole of hydrogen ions per litre.

pH is often measured with an electronic *pH meter* or with special dyes called *acid-base indicators.* The colour of an indicator depends on the concentration of hydrogen ions. *pH paper* contains several indicators that change colour at different pH's. When dipped into a solution, the paper's colour indicates the approximate pH of the solution. Many chemical reactions depend on the pH of a solution. pH is used to analyse body secretions, to test soil for suitability for certain crops, and for various industrial purposes.

**Phaëthon,** in Greek mythology, was the son of the sun god Helios and the sea goddess Clymene.

To learn whether Helios was truly his father, Phaëthon journeyed to the palace of the sun god in the east. There Helios, to reassure Phaëthon, promised to grant his son any favour. Phaëthon rashly asked to drive the sun chariot through the sky for one day. Helios reluctantly consented, but Phaëthon, being a mere mortal, was unable to control the sun chariot's fiery divine steeds. They flew so high that the earth froze and a scar—the Milky Way—was carved on the sky. They then flew so low that people were scorched black, streams dried up, and rocks split.

Zeus, king of the gods, rescued the world from destruction by striking Phaëthon with a thunderbolt. Phaëthon fell into a river and perished.

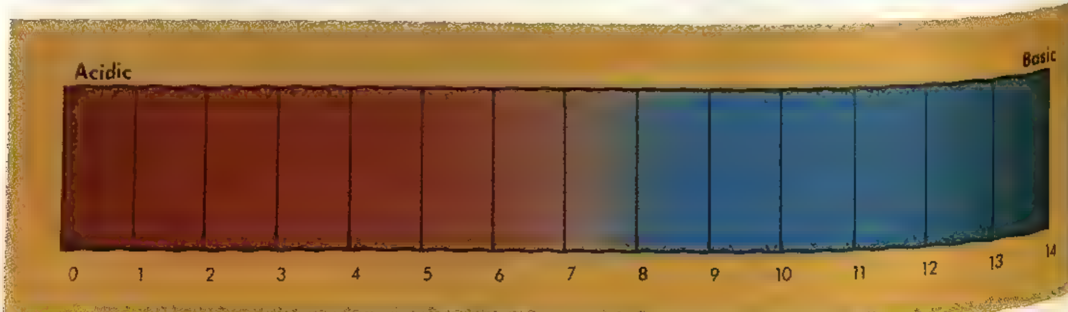
**Phagocytosis.** See **Immune system.**

**Phaistos** is an archaeological site on the Mediterranean island of Crete. It contains the ruins of an ancient palace. The palace at Phaistos was built by the Minoans, who also built the Palace of Minos at Knossos. See **Aegean civilization; Knossos.**

Phaistos stands on a ridge above the plain of the Mesara. Archaeologists working at the site since the early 1900's have found the remains of two palaces. The so-called New Palace was built after an older palace was destroyed, either by fire or by an earthquake, in about 1700 B.C. The New Palace was burned down when the

**The pH scale**

On the pH scale, a pH of 7 is neutral. Acidic solutions have a pH below 7, and basic solutions have a pH above 7. Special paper dipped in the solution indicates the pH by changing colour. The paper turns red if the solution is acidic. It turns blue if the solution is basic.



Mycenaeans, a people from mainland Greece, conquered Crete in about 1450 B.C. The palace at Phaistos was the home of Minoan rulers. Sports, animal sacrifices, and religious rituals may have taken place there.

**Phalanger.** See **Possum.**

**Phalanx.** See **Army** (Ancient armies).

**Phalarope** is a small sandpiperlike bird that breeds in the Northern Hemisphere and winters in the Southern Hemisphere. The *grey phalarope* and the *red-necked phalarope* breed in the Arctic and subarctic. They winter on the high seas of the Atlantic and Pacific oceans.

**The phalarope is a small swimming and wading bird.**

The phalarope female is larger and more brightly coloured than the male. She does the courting and establishes the nesting territory. The male builds the nest and incubates the eggs. But both the male and the female care for the young. Phalaropes are specialized for swimming with lobed, partially webbed toes. The plumage of their underparts traps air making phalaropes very buoyant.

**Scientific classification.** Phalaropes make up the phalarope family, Phalaropodidae. The grey phalarope is *Phalaropus fulicaria.* The red-necked phalarope is *P. lobatus.*

See also **Bird** (picture: Birds of the Arctic).

**Phar Lap** was a race horse bred in New Zealand. Harry Telford, a New Zealand trainer, bought him as a yearling for 168 British pounds. Between 1928 and 1932, Phar Lap won 36 out of 50 races in Australia and one in America. He won the Melbourne Cup in 1930. In one period in 1930 and 1931, he won 14 successive races. He died mysteriously at Menlo Park, in California, U.S.A., in 1932. His skeleton is in the National Museum in Wellington, New Zealand and his stuffed and mounted hide is in the National Museum in Melbourne, Australia.

**Pharaoh** was a title of the later kings of ancient Egypt. The Egyptians did not call their ruler pharaoh until the Eighteenth Dynasty (1554-1304 B.C.). Even then, pharaoh was not one of the king's most important titles. Writers of books in the Old Testament used the word *pharaoh* as a title for the king of Egypt.

The word pharaoh comes from two Egyptian words, *per-aa.* Per-aa means *great house,* and at first these words described the royal palace, not the king.

Egyptians considered the pharaoh a god and the son of a god. They thought he was the sky god Horus in human form, and the son of Re, the sun god. In theory, the pharaoh owned all the land and ruled the people. In reality, his power was sometimes limited by strong groups, including the priests and nobles. His actions were governed by rules of conduct that the Egyptians believed the gods had set down.

Akhenaton, also called Ikhnaton, the first pharaoh, outlawed the worship of more than one god. He also forced the Egyptians to worship him as a god-king. His wife, Nefertiti, helped him in his reforms.

See also **Egypt, Ancient** (History); **Akhenaton.**

**Pharaoh hound** is one of the oldest breeds of dogs. Pharaoh hounds originated in ancient Egypt, where they were used for hunting antelope and other game. Likenesses of these dogs have been found on the walls of the tomb of Pharaoh Antefa II, dating back to 2300 B.C.

**Phar Lap** became almost legendary for his amazing speed and gameness. In four years, he won a substantial amount in prize money for his New Zealand owner. He won the Melbourne Cup in 1930. In March 1932, he won the rich Agua Caliente Handicap in Mexico. He died a fortnight later.

In about 1500 B.C., the Phoenicians brought the pharaoh hound to the island of Malta, where it survived into modern times.

Pharaoh hounds are sleek dogs that stand from 53 to 70 centimetres high at the shoulder and weigh from 15 to 23 kilograms. Their short, flat, glossy coat is a rich tan or red. Pharaoh hounds have white toes and a starlike white marking on the chest. The tip of their whiplike tail is also white, and many of the dogs have a white line up the centre of the face. Pharaoh hounds "blush" when excited—that is, their nose and their erect ears change from the normal flesh colour to a deep rose. Their eyes are an unusual amber colour. Pharaoh hounds hunt by both sight and scent. They move swiftly and gracefully, and their bite is powerful.

**The pharaoh hound is a sleek, swift-running dog.**

**Pharisees** were members of an ancient Jewish group that became an important political party in Palestine during the reign of Queen Alexandra (76-67 B.C.). The political role of the Pharisees ended under the reign of Herod the Great (37-4 B.C.).

The Pharisees developed a philosophy that attributed an important role to fate and to God. They believed that though people have free will, fate or God will also play a role in people's actions. The Pharisees also believed that the soul is either rewarded or punished after death.

In the Gospels, the Pharisees were not politicians or philosophers, but Jews who stressed the laws of dietary purity. According to the Gospels, the Pharisees ate only with other "pure" Jews, while Jesus and His disciples ate with people who did not keep the law. Also, the Pharisees stressed the washing of hands, while the early Christians ignored this practice. Similarly, the Pharisees fasted, but Jesus and His disciples did not.

The Gospels often portrayed the Pharisees as the main Jewish opponents of Jesus, who easily overcame their opposition. In Matthew, John the Baptist called them "a brood of vipers," and in Luke, Jesus described them as hypocrites. These insults were directed at the Pharisees to contrast the ethical laws of Jesus and His followers with the purity laws and rituals of the group.

The Pharisees were often in conflict with another Jewish group called the Sadducees. Most of their disagreements revolved around issues of purity. The Pharisees believed that the purity laws should be kept by all Jews and were not limited to the priests and the area around the Temple in Jerusalem. The Pharisees believed that all Jews should eat as if they were priests presiding at the altar of the Temple.

**Pharmacist.** See Pharmacy.

**Pharmacology** is the study of the effects drugs have on living things. It deals with how drugs modify tissue and organ functions. Pharmacology is linked with both biology and chemistry. It is a recent science, but it is closely connected with one of the oldest, the giving of remedies to relieve diseases. In a long history of trial and error, people found that such plants as the poppy, deadly nightshade, and foxglove produced certain results. Minerals such as soda were also found to give desired reactions.

Pharmacology really began during the 1900's with the rise of chemistry. For the first time, the crude plant and mineral materials that act on living tissues could be analysed. The active part of a material could be separated and used as a drug or medicine. Its composition and the exact effect it would have could be determined. Pharmacologists have developed new drugs.

The branch of pharmacology relating to poison is *toxicology*. Nearly all chemical agents are harmful to living tissue if enough of them are taken. When a doctor knows how the chemicals act, he may use them for many different purposes.

See also **Drug; Pharmacy.**

**Pharmacopoeia,** also spelled *pharmacopeia*, is a book containing tables of drugs. It includes a statement of their properties, the doses in which they may be safely taken, and the standards that determine their strength and purity. The volume is compiled usually under the highest professional, sometimes governmental, authority. Today, almost all nations recognize the need for pharmacopoeias. Pharmacopoeias are continually revised and updated.

The first pharmacopoeia was the *Nuremberg Pharmacopoeia*. It was published in Germany in 1542. One of the earliest national pharmacopoeias was published in the United States in 1820. It is now called *The United States Pharmacopeia—The National Formulary*. The first *British Pharmacopoeia* was published in 1864, merging the three separate official pharmacopoeias published in London, Edinburgh, and Dublin. More recent publications include the *European Pharmacopoeia* and the *International Pharmacopoeia*, the latter produced by the World Health Organization and aimed particularly at developing countries. Another internationally important publication is *Martindale: The Extra Pharmacopoeia* which is based on the world's leading pharmacopoeias.

**Pharmacy** is the profession concerned with the preparation, distribution, and use of drugs and medicines. Members of this profession are called *pharmacists* or *druggists*. They were once called *apothecaries*. The word *pharmacy* also refers to a place where drugs are prepared or sold. Most pharmacies, sometimes called chemists or drugstores, also sell many other products.

**Duties of a pharmacist.** Pharmacists fill prescriptions written by doctors or dentists and prepare labels for the medicines. On the labels, pharmacists include di-

rections for patients given in the prescriptions. At one time, pharmacists *compounded* (prepared) their own medicines. Today, pharmaceutical manufacturers supply most drugs. But pharmacists still compound some medicines and are able to prepare antiseptic solutions, ointments, and other common remedies. They also advise people on the selection of nonprescription drugs, such as cold tablets. In addition, pharmacists are responsible for the legal sale of narcotics and poisonous substances.

See also **Drug; Pharmacology; Pharmacopoeia.**

**Pharos of Alexandria.** See **Seven Wonders of the Ancient World** (The Lighthouse; picture).

**Pharsalus, Battle of,** was fought between the armies of the Roman generals Julius Caesar and Pompey in 48 B.C. After his conquest of Gaul (58 to 51 B.C.), Caesar had become the most powerful military commander in the Roman world. Pompey and the Senate in Rome feared Caesar's power and ambition. Civil war broke out.

Pompey was at first victorious. When the rival armies met at Pharsalus (now Farsala), in Greece, Pompey's army of over 40,000 men outnumbered Caesar's.

However, Caesar's infantry withstood the enemy attack, and Pompey's cavalry retreated in confusion. Caesar then ordered a flanking counter-attack, which broke Pompey's army. Many of Pompey's troops fled. More than half of them surrendered. Caesar's army lost fewer than 250 dead.

See also **Caesar, Julius; Pompey the Great; Rome, Ancient.**

**Pharyngeal tonsils.** See **Adenoids.**

**Pharyngitis** is an infectious disease that affects the membranes of the throat and tonsils. It chiefly develops in children from 5 to 12 years of age.

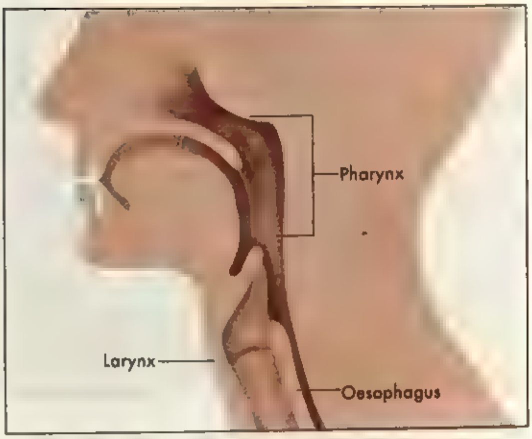
Pharyngitis is caused by bacteria of a type called *group A beta-haemolytic streptococci* (see **Streptococcus**). The bacteria generally spread from person to person through droplets of moisture sprayed from the nose and mouth. People called *carriers,* who harbour the streptococci but do not have symptoms of disease, can spread bacteria that cause pharyngitis. Laboratory tests can confirm the presence of pharyngitis bacteria in material taken from the patient's throat. See **Disease** (Spread of infectious diseases).

Symptoms of pharyngitis include sore throat, fever, headache, and, in some cases, chills, nausea, and vomiting. The patient usually experiences swelling of the tonsils and of the lymph nodes in the neck. The disease disappears rapidly following treatment. Untreated cases may last one to two weeks.

Various complications can follow pharyngitis. The infection may spread to the ears, sinuses, lungs, bones, or bloodstream. In other cases, patients later develop *rheumatic fever* or a kidney disease called *acute glomerulonephritis* (see **Rheumatic fever; Nephritis**). Prompt treatment of pharyngitis with penicillin can prevent the infection from spreading to other parts of the body. Such treatment also eliminates the risk of rheumatic fever but does not always prevent acute glomerulonephritis.

Many doctors advise that other members of the patient's household be tested for the presence of streptococci. Those who are found to be carrying the bacteria are treated with penicillin.

**Pharynx** is a cone-shaped tube that connects the nose and mouth with the voice box and oesophagus. The




**The pharynx** is a muscular, cone-shaped tube that connects the nose and mouth with the *larynx* (voice box) and oesophagus. It serves as a passageway for both air and food.

pharynx is about 13 centimetres long and has muscular walls lined with mucous membrane. It serves as a passageway for both air and food. In addition, the pharynx plays an important role in speech, especially in the production of vowel sounds.

When a person breathes in, air enters the pharynx from the nose or mouth. The breath then passes through the *larynx* (voice box) and *trachea* (windpipe) into the lungs. This route is reversed when a person exhales.

Food enters the pharynx from the mouth. When a person swallows, a flap of cartilage called the *epiglottis* covers the opening of the larynx, and the vocal cords automatically clamp shut. These actions keep food from entering the trachea. Instead, it travels down the oesophagus to the stomach.

**Phase,** in chemistry, is any distinct and uniform physical part of a mixture that is separated from the other parts of the mixture by definite boundaries. For example, in a mixture of ice, liquid water, and water vapour, each form is physically distinct from the others, and the mixture has three *phases.* Oil and water form two phases with a definite boundary between the phases. *Solutions* are one-phase systems, because they are *homogenous* mixtures—that is, they cannot be separated mechanically.

**Pheasant** is the name of several species of medium-to-large birds closely related to the domestic chicken. Most pheasants are native to Southeast Asia, China, Japan, or central Asia. However, some species have been brought to many other parts of the world, where they are bred and released for hunting. People hunt pheasants for sport and for their tasty meat. Pheasants are also sought for their attractive feathers.

**Appearance and habits.** Most pheasants have a long tail and a short, stout bill. Some have flaps of red skin on their heads forming *combs* or *wattles.* Male pheasants are called *cocks.* Nearly all cocks have beautiful patterns of brightly coloured feathers. Female pheasants, called *hens,* have duller feathers of brown and tan with black markings.

Most pheasants inhabit woodlands, but some species

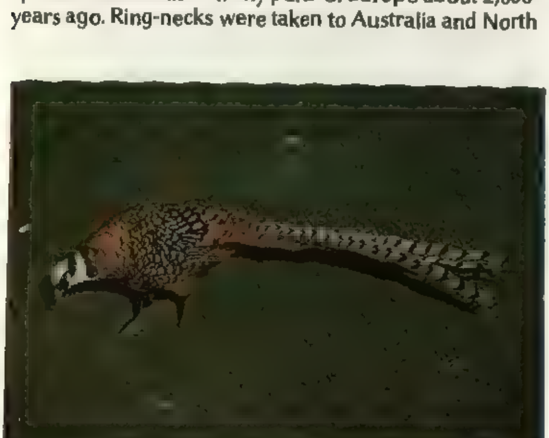
**Ring-necked pheasants** are popular game birds. The male's head and neck have bright feathers. The female is plainer.

**Male golden pheasants** have bright yellow heads and brilliant red breasts. Their colours make them attractive to females.

prefer cultivated fields. Others live in grasslands high in the Himalaya. Most pheasants do not undertake long migrations, but many make short seasonal journeys in search of food. Pheasants eat seeds, fruits, roots, greens, flowers, and insects and other small animals without backbones. Pheasants spend most of their time on the ground, although many species perch in trees at night. They can fly only for short distances, but may reach speeds of about 60 kilometres per hour.

In spring, pheasant cocks fight for possession of a mating area. They then attract hens by showing off their elegant feathers. The cocks accompany such elaborate displays with cackles, crows, screams, and whistles. The calls of the hens are limited mostly to clucks and peeps. A cock's territory usually includes several hens, with which he mates. Nearly all pheasants nest on the ground. The hen builds a nest of twigs and leaves in a secluded spot. But sometimes pheasants use a nest left in a tree. Hens lay from 2 to 15 eggs. Their eggs are plain or speckled and may be white, tan, or olive.

**Kinds of pheasants.** There are about 35 species of pheasants. One familiar species, the *ring-necked pheasant,* was found originally in central Asia. The Romans spread these birds to many parts of Europe about 2,000 years ago. Ring-necks were taken to Australia and North America during the 1800's. Male ring-necks grow to a length of about 75 to 90 centimetres, including the tail. Their head and neck are covered with shiny greenish-blue feathers and their body is brown, black, and white. Many cocks have a white band around their neck. Red skin encircles their eyes. The hens are mottled brown and lack the neck band. They grow to a length of about 50 to 65 centimetres.



**The Reeves pheasant** is one of the largest species. Adult males measure up to 2 metres long, including the tail.

Another well-known species, the *golden pheasant,* adapts well to captivity and is a favourite in zoos. The male has a golden-yellow head and brilliant red breast. Golden pheasants come from the mountain forests of Tibet and central China, where they are now rare.

The large *Reeves pheasant* lives in small groups in the mountains of China. As part of its courtship dance, the cock ruffles its shimmering golden feathers and leaps repeatedly high into the air. During flight, it may use its long tail as a rudder or a brake.

**Scientific classification.** Pheasants belong to the family Phasianidae. The ring-necked pheasant is *Phasianus colchicus,* the golden pheasant is *Chrysolophus pictus,* and the Reeves pheasant is *Syrmaticus reevesi.*

See also **Bird** (picture: How wing shape affects flying skills); **Tragopan.**

**Pheidippides.** See Marathon.

**Phenolic resin.** See **Bakelite; Plastics** (The invention of bakelite; table: Kinds of plastics).

**Phenology** is the study of when certain biological events that depend on climate take place. Phenologists study how these events are affected by seasonal weather changes. The events include the migration of birds, the hibernation of animals, and the sprouting and flowering of plants. Farmers and others whose work is affected by weather can use the information to plan their activities. For example, in some areas alfalfa is ready to be cut about 30 days after the common lilac blooms. Farmers can predict when they will have to cut their alfalfa by observing when lilacs bloom.

Scientific organizations in many countries have formed networks of people who observe and report on certain phenological events. The organizations use the information to make *phenological maps.* Lines on the maps connect the places in which living things reach a certain stage at the same time.

Artificial satellites provide data on atmospheric temperatures, solar radiation, and the reflection of the earth's surface. This information helps scientists detect certain phenological events worldwide. For example, phenologists use this information to determine when vegetation will become green—or turn brown—in various regions. These data can be used to develop mathematical models of the life cycles of plants and animals raised in different climates.

**Phenolphthalein** (chemical formula, $C_{20}H_{14}O_4$) is a chemical compound used as an indicator of alkalinity or acidity, and as a laxative. It is also used in making dyes. It is prepared by heating phenol and phthalic anhydride with sulphuric acid. Pure phenolphthalein forms small white crystals that dissolve in alcohol or ether. It turns red in the presence of an alkaline substance. As a laxative, phenolphthalein is part of many advertised medicines. It is one of the least poisonous of common laxatives, but some people are allergic to it. It must be used with care.

**Phenomenology** is a philosophy that was developed by the German philosopher Edmund Husserl in the early 1900's. Husserl wanted to understand how consciousness works in order to better understand human experience. Consciousness refers to the power of the mind to be aware of acts, sensations, and emotions. Husserl believed that everything we know about reality derives from our consciousness.

For phenomenologists, experience has two parts. The first part consists of *objects of consciousness* (the things of which one is conscious). Objects of consciousness, which include material objects, ideas, and wishes, are called *phenomena*. The second part of experience consists of *acts of consciousness,* such as perceiving, believing, thinking, and desiring. Phenomenologists believe that all acts of consciousness are related to objects of consciousness and thus must also be considered phenomena. This relationship is called *intentionality*.

The phenomenological method starts with the theory that people normally make certain assumptions about their experiences. They consider the things they have been taught, and remember past experiences. Such presuppositions limit their experiencing of phenomena. Phenomenologists realize that it is impossible to entirely eliminate these presuppositions from the mind. Instead, they try to expand their experiencing of phenomena by dealing with the presuppositions critically. One critical method involves *fantasy variations*. The philosopher varies the presuppositions, imagining how the experience would be perceived under varying circumstances. The features of the experience that remain constant despite the variations are considered its *essence*.

Husserl has had many followers. They include the French psychologist Maurice Merleau-Ponty and the German philosopher Martin Heidegger. Both men argued that phenomenology should not be limited to an analysis of consciousness. Instead, they used the phenomenological method to analyse human existence in general. The method has also been successfully applied to specific fields, such as anthropology, law psychiatry, psychology, religion, and sociology.

**Phenylketonuria (PKU)** is a hereditary disease that results in mental retardation unless treated during early infancy. It occurs chiefly in people of western European ancestry. The bodies of people with PKU accumulate too much *phenylalanine,* one of the amino acids that make up proteins. For unknown reasons, an excess of phenylalanine in an infant's body harms development of the brain and intelligence, leading to severe mental retardation.

PKU is caused by a *mutation* (change) in a gene that alters the function of the enzyme *phenylalanine hydroxylase*. This enzyme normally converts phenylalanine to the amino acid *tyrosine*. In PKU patients, the conversion of phenylalanine to tyrosine does not take place properly. Phenylalanine is an essential part of the human diet and it builds up in the bodies of PKU patients who eat normal foods.

Doctors diagnose PKU by testing the infant's blood a few days after birth. An abnormally high level of phenylalanine may indicate the presence of the disease. Further laboratory tests confirm the diagnosis.

In treating PKU, doctors prescribe a diet low in phenylalanine. Such a diet includes fruits and certain vegetables and cereals. Milk, milk products, meat, fish, and other high-protein foods should be avoided. Treatment must begin before the patient is two months old to ensure normal mental development. Many doctors recommend that treatment continue throughout childhood. Women with PKU may follow a special diet before and during pregnancy to protect the brain development of an unborn baby.

**Pheromone** is a chemical substance released by many kinds of animals to communicate with other members of their species. The animals that secrete pheromones range from one-celled organisms to rhesus monkeys and many other mammals.

Both males and females use pheromones to establish territories, warn of danger, and attract mates. For example, certain ants, mice, and snails release *alarm pheromones* when injured or threatened. The odour warns other members of the species to leave the area. A pheromone secreted by the queen bee of a hive prevents all the other females in the group from becoming sexually mature. The queen then becomes the only bee in the hive that can mate and lay eggs. Scientists have discovered evidence of pheromones in human beings but do not know whether they affect human behaviour.

Since 1959, chemists have developed synthetic pheromones that are used to control insect pests. Unlike many pesticides, pheromones do not harm the environment. Artificial female pheromones of such insects as moths and beetles are used to bait traps that capture males of the same species. In another method of pest control, called *communication disruption,* farmers spread their crops with fibres soaked in an insect pheromone. The odour of the pheromone prevents the male insects from finding the females for mating.

**Phidias** (490?-420? B.C.) was the greatest sculptor in ancient Greece. His artistry was largely responsible for the High Classical style of sculpture during the Golden Age of Athens in the 400's B.C.

Phidias is best known for his designs for the sculptures on the Parthenon. Phidias conceived and designed these works, though he may not have actually made them. He created statues of gods and goddesses primarily in marble, but occasionally in gold and ivory. These statues were unrivalled in the ancient world for their

majesty and grandeur. Especially important are his statues of Athena Parthenos, Athena Lemnia, and Olympian Zeus.

Phidias was a close friend of Pericles, chief of the Athenian state. Through Pericles, Phidias played a central role in rebuilding temples and statues destroyed by a Persian invasion in 480 B.C.

See also **Elgin Marbles; Greece, Ancient** (picture: Athena); **Parthenon; Seven Wonders of the Ancient World** (The statue of Zeus).

**Philadelphia** was the name given to several cities by the ancient Greeks. The name means *brotherly love.* One was a town in Lydia founded in the 100's B.C. by King Attalus II Philadelphus of Pergamum. It was a centre of early Christianity. A pagan inscription found there indicates that its people followed a strict moral code. Alaşehir, Turkey, stands on the site now. Another ancient Philadelphia, in Palestine, began as a city called Rabbath-Ammon. But the Egyptian king Ptolemy II Philadelphus conquered it, renamed it, and introduced Greek customs and culture. The capital of Jordan, Amman, stands on this site.

**Philadelphia** (pop. 1,585,577; met. area pop. 4,856,881) is the birthplace of the United States of America. The Declaration of Independence and the Constitution of the United States both were adopted in Philadelphia's historic Independence Hall. The city was the capital of the American Colonies during most of the American Revolution (1775-1783).

According to the 1990 census, Philadelphia ranked as the fifth largest city in the United States. About 1 $\frac{1}{2}$ million people live in Philadelphia.

Philadelphia lies in southeastern Pennsylvania on the Delaware River. The river flows into the Atlantic Ocean and helps make Philadelphia one of the nation's busiest freshwater ports. The city also is a centre of U.S. culture, education, finance, and health care.

William Penn, an English Quaker, founded Philadelphia in 1682. Penn, who had been persecuted for his Quaker beliefs, planned Philadelphia as a centre of religious freedom. The word *philadelphia* means *brotherly love* in Greek, and Philadelphia was nicknamed the *City of Brotherly Love.* It also became known as the *Quaker City* because many of its first settlers were Quakers. Today, the American Quakers have their headquarters in Philadelphia. During the 1700's, Philadelphia became the largest and wealthiest city in the American Colonies.

Few cities in the United States can match Philadelphia's historic attractions. Every year, millions of visitors thrill to the sight of Independence Hall and the Liberty Bell. Many visitors enjoy touring Carpenters' Hall and Congress Hall, where Benjamin Franklin, Thomas Jefferson, and other early leaders laid the foundations of a new nation. Philadelphians also take pride in the city's world-famous orchestra; excellent colleges and universities; scenic parks; and outstanding museums of art, history, and science.

Philadelphia faces problems common to many other large cities. For example, thousands of its people live in slums. Many of them are poorly educated and lack work skills. Many earn a low income or have no job at all. Such conditions help cause a high crime rate in the community. But Philadelphia does not have the huge sums of money needed to help solve its problems.

**The city.** Philadelphia covers about 375 square kilometres, including 23 square kilometres of inland water. It lies in Philadelphia County, but the city and the county have the same boundaries. Thus, Philadelphia is both a city and a county.

The Delaware River runs east and south of Philadelphia and separates the city from the state of New Jersey. The Schuylkill River flows through Philadelphia and into the Delaware at the southern edge of the city. Central Philadelphia, which is called *Center City,* lies between the two rivers. Philadelphia's chief residential districts are located to the north, south, and west of Center City. The northern area includes two large sections known as northwestern Philadelphia and northeastern Philadelphia.

Philadelphia's huge City Hall covers about 2 hectares in the centre of the city. It is one of the largest city halls in the United States. A tower rises from the front part of the white granite and marble building. On top of the tower stands a bronze statue of William Penn. The statue, which measures 11 metres tall and weighs 24,278 kilograms, ranks as the world's largest sculpture on top of a building. The distance from the ground to the top of the statue is nearly 167 metres.

Philadelphia's chief historic area lies east of the shopping district. It centres on the 9-hectare Independence National Historical Park, which includes Independence Hall. Inside this handsome red brick building on Chestnut Street, visitors may see the room where the Declaration of Independence and the Constitution were adopted. The famous Liberty Bell, rung in 1776 to announce the adoption of the Declaration, hangs in a glass-enclosed structure near Independence Hall. Also nearby are Congress Hall, the home of Congress from 1790 until 1800; and Carpenters' Hall, where the First Continental Congress met in 1774.

About 35 brick houses built during the early 1700's line Elfreth's Alley, a narrow, cobblestone street between Arch and Race streets. It is the nation's oldest street of continuously occupied homes. On Fifth Street, the largest United States Mint produces about 350 million U.S. dollars worth of coins yearly.

**People.** Philadelphia has attracted millions of immigrants since colonial times. Most of these people came from Europe, and large numbers of blacks moved there from the South. Today, about three-fifths of the city's people are white, and most of the rest of the Philadelphians are black.

**Ethnic groups.** English and Welsh Quakers who accompanied William Penn were the first settlers in Philadelphia. Other Europeans followed in three major waves of immigration. Many English people arrived throughout the 1700's. In the second wave, between the 1830's and 1880's, large numbers of families came from England, Germany, Ireland, Scotland, and Wales. In the third wave, which took place in the early 1900's, many immigrants came from Austria, Hungary, Italy, Poland, and Russia.

Blacks began to come to Philadelphia during the 1600's because of the Quaker belief in racial equality. Thousands of Southern blacks arrived during and after World War II (1939-1945).

Today, Philadelphia's about 640,000 blacks make up about two-fifths of the city's population and form its

**Philadelphia's City Hall,** *centre,* ranks as one of the largest city halls in the United States. It covers about four square blocks. Skyscrapers and a wide plaza nearby occupy Penn Center, a bank and office complex that has become a landmark of Philadelphia's urban renewal programme.

largest ethnic group. People of Italian ancestry make up the next largest ethnic group, and they are followed by residents of Irish or German descent. Other large groups of Philadelphians include inhabitants of English, Puerto Rican, Polish, Russian, or Ukrainian descent.

About half of Philadelphia's black residents live in North Philadelphia. Many Italians live in South Philadelphia. Most of the children and grandchildren of the city's immigrants live in the newer sections of Philadelphia or in the suburbs.

**Social problems.** Philadelphia, like other large cities, faces such problems as crime, poverty, and slums. Most of the city's poor people are blacks or Spanish-speaking people who suffer from discrimination or lack education and necessary skills. They live in run-down dwellings. Large numbers have no jobs, and many others work long hours for low wages. These conditions have contributed to the city's high crime rate.

**Economy.** Philadelphia is a leading centre of commerce in the United States. For many years Philadelphia was one of the world's leading manufacturing cities. But since about 1950, service industries have grown rapidly while manufacturing has declined in the city. Today, Philadelphia relies less on manufacturing than do most other large U.S. cities. About 85 per cent of the city's workers are employed in service industries. Philadelphia's most important service industries are trade, finance, and health care.

The wholesale trade industry in Philadelphia relies heavily on the city's port. The Port of Philadelphia is one of the busiest freshwater ports in the United States. It handles nearly 27 million metric tons of cargo annually. Grain and coal are the city's major exports. Philadelphia's retail trade industry is strengthened by the large numbers of tourists that visit the city.

Manufacturing employs about 15 per cent of Philadelphia's workers. Philadelphia ranks third in clothing production among the U.S. cities, after New York and Los Angeles. Philadelphia is also a major producer of chemicals, fabricated metal products, and processed foods.

About 150 clothing factories operate in Philadelphia. The major products of the city's clothing industry are business suits and dresses.

The production of chemicals is one of Philadelphia's fastest-growing manufacturing activities. Pharmaceuticals are the city's most valuable type of chemical product. Other leading chemical products that are produced in Philadelphia include industrial chemicals and pesticides.

**History.** The Delaware Indians lived on the site of what is now Philadelphia long before Europeans arrived. British and Dutch sailors visited the area in the early 1600's. In the 1640's, Swedish families established the first permanent settlement there. The Dutch, English, and Swedes fought over the area, and Great Britain finally won control of it in 1674.

**Terraced houses** are the most common type of housing in Philadelphia. Each of these houses shares at least one wall with the house next door. Most of the structures are two- or three-storey brick buildings.

In 1681, King Charles II of England granted William Penn a charter to establish what became the Pennsylvania Colony. Penn chose the site of Philadelphia for the capital, which he visualized as a "greene countrie towne." He arrived there in 1682, and the town became the capital of Pennsylvania in 1683.

Penn had advertised his guarantee of religious liberty before he left Europe, and thousands of persecuted people came to Philadelphia.

In 1723, a 17-year-old apprentice printer named Benjamin Franklin moved to Philadelphia from Boston. A few years later, he had become Philadelphia's most famous civic leader.

In the mid-1700's, Philadelphia became a centre of colonial protest against British taxes and trade policies in America. Later, in the mid-1800's, it became a centre of the antislavery movement. In the late 1800's and early 1900's, the city attracted thousands of eastern European Jews, Italians, Poles, and Slavs.

**Related articles** in *World Book* include:

Franklin, Benjamin
Liberty Bell
Penn, William
Pennsylvania

**Philanthropy** is the promotion of the well-being of human beings by individuals and groups who contribute their services or dedicate their property and money. Philanthropy differs from charity in that it usually helps a large group or an institution, rather than one or a few individuals.

Nearly all civilizations have practised some type of philanthropy. The ancient Jews levied a *tithe* (tax) for the poor. In ancient Egypt and Greece, royal families gave gifts to establish libraries and universities. The medieval church supported hospitals and orphanages.

In Anglo-Saxon law, the legal basis of philanthropy rests on the Statute of Charitable Uses, passed in England in 1601. The statute approved governmental aid to poor, aged, and orphaned people. It also provided for assistance to such institutions as hospitals, schools, and universities.

In the United States, gifts from private donors helped establish many early churches, colleges, and hospitals. For example, gifts helped create and support Harvard College, founded in 1636. In 1790, Benjamin Franklin established a fund to aid worthy young men. In 1829, James Smithson set aside money for the creation of the Smithsonian Institution (see **Smithsonian Institution**). Other people with large fortunes, such as John D. Rockefeller and Andrew Carnegie, established foundations that have worked to better humanity both in the U.S.A. and internationally.

**Related articles** in *World Book* include:

**American philanthropists**

Astor (William B.)
Baldwin, Matthias W.
Carnegie, Andrew
Cornell, Ezra
Du Pont de Nemours (Pierre (1870-1954))
Eastman, George
Ford, Henry
Ford, Henry, II
Guggenheim, Meyer
Mellon, Andrew
Morgan (John; John, Jr.; Junius)
Pulitzer, Joseph
Rockefeller (John D.; John D., Jr.)
Stetson, John B.
Vanderbilt, Cornelius

**British philanthropists**

Rhodes, Cecil J.
Rothschild (family)
Selkirk, Earl of
Smithson, James
Yale, Elihu

**Other philanthropists**

Medici (family)
Nobel, Alfred B.

**Philately.** See **Stamp collecting.**

**Phileas Fogg.** See **Verne, Jules.**

**Philemon, Epistle to,** is the 18th book of the New Testament of the Bible. It is a letter from the apostle Paul to Philemon, a Christian associate of Paul. The apostle wrote the letter from prison, possibly in Rome, about A.D. 60. The letter was carried by Onesimus, a slave who had run away from Philemon, whom Paul was sending back to his owner. Paul asks Philemon not to punish Onesimus, and even seems to suggest that Philemon send Onesimus back to Paul to work with the apostle. The Epistle is the shortest of Paul's letters.

**Philemon and Baucis** are the central characters in a minor legend of Ancient Greece. Philemon, a pious and dutiful peasant, lived with his devoted wife Baucis in the

land of Phrygia. One day, two travellers called at their little cottage seeking shelter. Philemon and Baucis received them hospitably and gave them food and rest. The travellers were in fact the gods Zeus and Hermes in disguise. They had asked neighbours of Philemon and Baucis for shelter, but had been refused. When the gods sent a flood to destroy Phrygia, all the inhabitants were drowned except Philemon and Baucis. Their cottage became a temple, and they became the temple's priest and priestess. When asked for a wish, they requested that they both die at the same moment. After a long life, their wish was granted and they were turned into trees.

**Philidor.** See **Chess** (History).

**Philip** was the name of several French kings. Most important were Philip II, Philip IV, and Philip VI.

**Philip II** (1165-1223), known as Philip Augustus, was the first great king of the Capetian dynasty. A clever statesman, he not only expanded the kingdom of France, but also made the monarchy powerful.

Philip came to the throne when his father, Louis VII, died in 1180. His first triumph was adding Picardy to his kingdom. This region was promised him as a dowry, but he had to force his father-in-law to give it up.

Philip then determined to gain the English possessions in France for himself. To weaken England's power, he encouraged the sons of the English king, Henry II, to revolt against their father. Henry's oldest son, Richard the Lion-Heart, took the English throne in 1189, and he and Philip went together on the Third Crusade. But Philip soon returned home and began to make trouble for the absent Richard.

**Philip II**

In 1194, Richard returned and began a war against Philip, but was killed in battle in 1199. Richard's brother, King John, went to war with Philip in 1202. Philip took advantage of John's mistakes and successfully conquered most of the English holdings in France. John kept only the southern part of Aquitaine, or Guyenne. Philip's victory at the Battle of Bouvines in 1214 established his hold on the conquered regions.

Philip then held greater powers than any of his strongest barons, and he carried out a series of governmental reforms. These reforms laid the basis for the later rule of the French kings.

**Philip IV** (1268-1314) was called "the Fair" because he was considered the handsomest man of his time. He came to the throne in 1285. By his marriage, he added the region of Champagne to the kingdom of France. Then he began an unsuccessful war with England in 1294. A later war against Flanders resulted in a defeat for Philip at Courtrai in 1302.

That same year, Philip quarrelled with Pope Boniface VIII, because Philip taxed Roman Catholic churches against the pope's orders. In 1303, Philip had the pope arrested at Anagni, Italy. However, the townspeople freed the pope. In 1305, a French archbishop became Pope Clement V. The new pope moved to Avignon,

Detail of an illuminated French manuscript (about 1450).

**Philip IV,** *left,* received the homage of King Edward I of England, *kneeling,* in 1286, a year after Philip became king of France.

France, in 1309 and then carried out the French king's orders, which included suppressing the Knights Templars (see **Knights Templars**).

**Philip VI** (1293-1350), a nephew of Philip IV, was the first king of the Valois dynasty. He came to the throne in 1328. That same year, he defeated the Flemish army at Cassel and gained the region of Guyenne. But relations with England were unfriendly, and in 1337 the Hundred Years' War broke out. Philip was defeated several times, but succeeded in extending his rule throughout many more regions of France. He bought the rights of the last lord of Viennois, who had the title of Dauphin (see **Dauphin**). This title was then passed to the eldest son of each French king until 1830.

**Related articles** in *World Book* include:

| | | |
|---|---|---|
| Capetian dynasty | France (History) | Salic law |
| Crécy, Battle of | Hundred Years' War | Valois |

**Philip** was the name of several kings of Spain. Two, Philip II and Philip V, became especially famous.

**Philip II** (1527-1598) ruled from 1556 until his death. He succeeded his father, Charles I of Spain. Charles ruled the Holy Roman Empire as Charles V, but Philip did not become emperor. Philip broke the power of the Turks in the Mediterranean Sea in 1571, and also conquered Portugal in 1580. But his reign marked the beginning of the destruction of the Spanish empire. In 1581, the Netherlands, one of the most valuable possessions of Spain, declared its independence. After Sir Francis Drake and other British captains attacked and plundered Spanish possessions in Mexico and South America, Philip sent the "Invincible Armada" against England in 1588. The British defeated this great fleet, and damaged Spanish prestige. See **Spanish Armada.**

Philip regarded himself as the champion of the Roman Catholic faith, and supported the harsh measures of the Inquisition. He was born at Valladolid, Spain, and was married to Queen Mary I of England. See **Mary** (I); **Escorial; Netherlands** (History); **Spain** (History).

Detail of an oil painting on canvas (1819) by Jean Auguste Dominique Ingres

**Philip V** was the first Bourbon king of Spain. This painting shows him awarding a decoration to a French military leader who served him.

**Philip V** (1683-1746) became ruler of Spain in 1700. He was the first of the Spanish kings of the royal Bourbon family of France (see **Bourbon**). Other nations refused to recognize him as king, and the War of the Spanish Succession began. In 1713, Philip finally won recognition as king, but he lost many of his territories to Austria and England. Philip's second wife, Elizabeth Farnese of Parma, caused Philip much difficulty. He abdicated in 1724 in favour of his son, Louis, but returned in eight months when Louis died.

Philip was born in Versailles, France. He was the grandson of Louis XIV of France and of Maria Theresa of Spain. Philip inherited the throne through Charles II of Spain, Maria Theresa's brother.

See also **Succession wars** (The War of the Spanish Succession).

**Philip II** (382-336 B.C.) was a great Macedonian king who became master of Greece. He was the father of Alexander the Great, who carried out many of his father's dreams of conquest. See **Alexander the Great**.

Philip, the youngest son of Amyntas II, was born in Pella. In his early youth, he spent several years as a hostage in Thebes. While in Thebes, Philip learned much of military science from the foremost military leaders of the time.

Philip was named regent for his nephew in 359 B.C. when his older brother died. But Philip soon made himself king. Within two years, he put down all opposition and established himself securely on the throne.

Philip immediately began to carry out his plans of conquest by attacking the Greek towns on his border. He had reorganized the Macedonian army so that it was far superior to the Greek armies. He used the heavy phalanx formation of infantry attack as a striking arm and heavy cavalry for the knockout blow (see **Army** [Ancient armies]). He developed the light infantry and light cavalry and used them in an all-out pursuit which destroyed his opponents. Within a few years, he controlled most of the small states in Greece, and his power extended as far north as the Danube River.

In Athens, Demosthenes understood Philip's plans, and he thundered forth against Philip in his famous speeches, which came to be known as the *Philippics*. But the Athenians refused to listen to Demosthenes. They did not believe Philip was a threat to Athens, because he was at war with Thrace at the time. In 338 B.C., Demosthenes was finally able to rouse the Athenians, and they joined with Thebes in a defensive league against Philip. But the Macedonian king defeated the allied armies in the battle of Chaeronea that same year, and ended Greek independence.

Philip formed Greece into the League of Corinth, a political organization. All the cities were included except Sparta, which had never been conquered. The cities were represented in the *Synhedrion* (council) by population and districts. Non-Greek nations were allowed to join. Philip was chosen by the League to command the Greek forces to attack Persia. He was killed while preparing for this war.

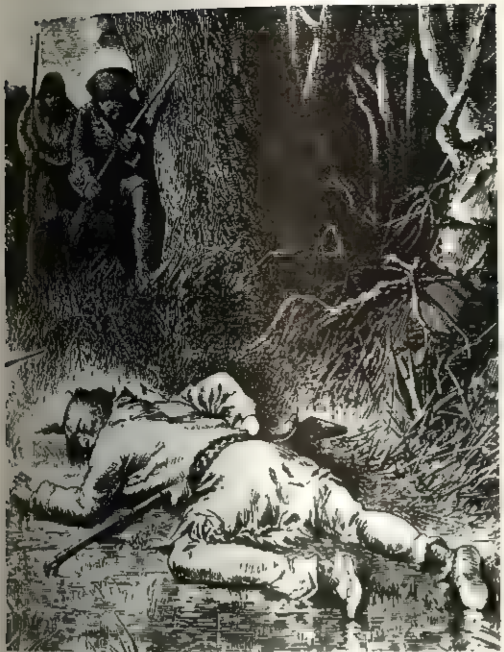
See also **Demosthenes; Macedonia; Olympias.**

**Philip, King** ( ? -1676), became chief of the North American Wampanoag Indians in 1662. His Indian name was Metacomet. He was the son of Massasoit, a friend of the Pilgrim Fathers (see **Pilgrim Fathers**). Philip succeeded his older brother as chief.

As Philip saw the increasing amounts of land taken by the white settlers, he grew concerned that the colonists would in time destroy his people. Soon after he became chief, he began preparations to massacre all the white settlers in New England. The great struggle known as King Philip's War began in 1675. Philip burned both white and Indian settlements. Men, women, and children were killed on both sides. King Philip almost succeeded in wiping out the English settlements in New England. But after the defeat of his forces by the English

Ivory miniature carving (about 350-325 B.C.)

**Philip II** was a great Macedonian king. He had conquered much of Greece before he was assassinated in 336 B.C.



**King Philip** was hunted down and killed in a swamp by a group of American colonists and their Indian allies.

colonists, Philip was hunted down and killed in a swamp near present-day Bristol, Rhode Island, in 1676. The war then ended in southern New England, but fighting continued in northern New England until 1678.

See also **Indian wars** (King Philip's War).

**Philip, Prince** (1921- ), is the husband of Queen Elizabeth II of Great Britain. His full title is His Royal Highness The Prince Philip, Duke of Edinburgh, Earl of Merioneth, Baron Greenwich.

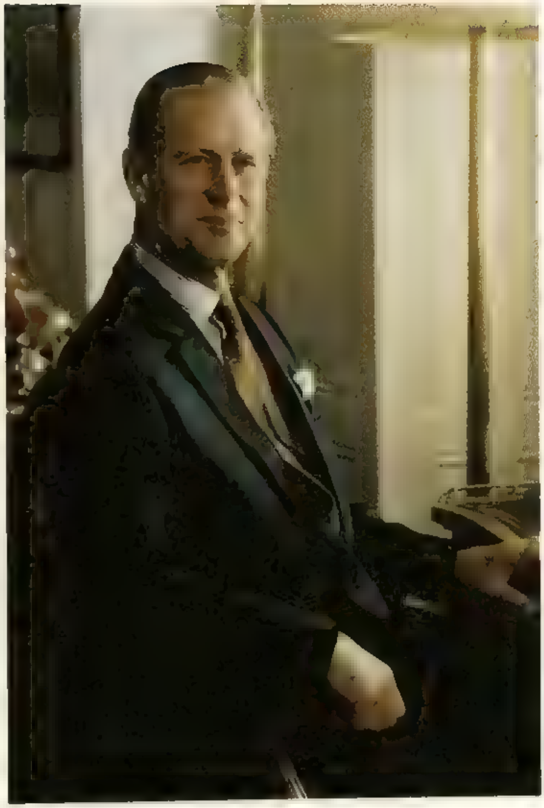
Prince Philip was born on the Greek island of Corfu on June 10, 1921. His father, Prince Andrew of Greece, was the fourth son of King George I of Greece. Philip's mother, Princess Alice of Battenberg, was a great-granddaughter of Queen Victoria of Britain and the sister of the British military leader Louis Mountbatten.

Philip was educated in France, Germany, and Britain. He attended Gordonstoun school in Scotland and the Royal Naval College in Dartmouth. During World War II (1939-1945), he served as a lieutenant in the British Navy with the Mediterranean and the Pacific fleets.

In 1947, Philip gave up his claim of succession to the throne of Greece. He became a British citizen, taking Mountbatten for his last name. He married Princess Elizabeth on Nov. 20, 1947. Princess Elizabeth's father, King George VI, made Mountbatten Duke of Edinburgh. Elizabeth became queen in 1952. In 1957, she gave her husband the title of Prince of the United Kingdom. The couple have four children (see **Elizabeth II**).

As *prince consort* (husband of the queen), Prince Philip has no formal role in government. He performs public duties in Britain and the Commonwealth of Nations as a representative of the British Crown. He also accompanies Queen Elizabeth on tours and visits.

Prince Philip's interests include technological research and industry, especially their effect on living conditions and the environment. In 1961, he became president of the British branch of the World Wildlife Fund (now the World Wide Fund for Nature). In 1981, he became the organization's international president. He has travelled widely to promote its aims. Prince Philip, a well known public speaker, has published many collections of his speeches, including *Down to Earth* (1988). He also enjoys boating and flying.



**Prince Philip** often represents Queen Elizabeth at affairs of state. He also accompanies her on all royal tours of the British Commonwealth of Nations. He takes a personal interest in scientific research and education, and wildlife conservation. His other interests include sailing, polo, painting, and carrage-driving.

See also **Elizabeth II; United Kingdom** (picture).

**Philip of Bethsaida, Saint,** was one of the 12 apostles of Jesus Christ. He is prominent in the New Testament Gospel of John, in the Bible. Philip was one of the first people to be called as an apostle. He was present at the miracle of the feeding of the multitude (John 6:5-7). When a group of Greeks wanted to see Jesus, they approached Philip for an introduction (John 12:20-22). At the Last Supper, Philip asked to see the Father. Jesus replied, "He that hath seen me hath seen the Father" (John 14:8, 9). This special interest in Philip indicates that he was highly regarded by the author of the Gospel of John. Philip should not be confused with Philip the Evangelist, who is mentioned in the Acts of the Apostles.

According to later tradition, Philip preached in Asia Minor (now Turkey), where he was martyred. His feast day in the Roman Catholic Church is shared with James

Detail of a mosaic in San Vitale Church, Ravenna, Italy

**Saint Philip of Bethsaida** was one of the 12 apostles of Jesus Christ. He was one of the first to be called as an apostle.

the Less on May 3. The Eastern Orthodox Churches celebrate his feast day on November 14.

See also **Apostles.**

**Philip the Evangelist** was an early Christian. He is listed in the Acts of the Apostles as one of the seven deacons chosen by the apostles to assist with the practical activities of the early church in Jerusalem. He should not be confused with Philip the Apostle, one of the 12 apostles.

According to Acts, Philip worked in Judea and Samaria. Later tradition says he was the bishop of Tralles in Turkey. His feast day in the Roman Catholic Church is on June 6. The Eastern Orthodox Churches celebrate his feast day on October 11.

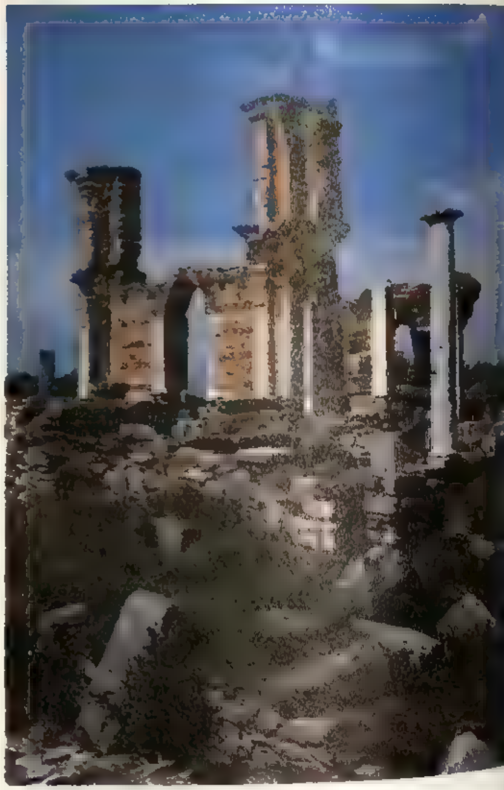
**Philipe, Gérard** (1922-1959), was a French stage and film actor. He won international fame with his brilliant performances in the classic French films *La Beauté du Diable* (Beauty and the Devil, 1950), *La Ronde* (1950), and *Les Belles de Nuit* (Beauties of the Night, 1952).

Philipe was born in Cannes. He studied acting at the Paris Conservatoire of Dramatic Art. He first appeared on the stage in Nice, in 1941. He made his Paris debut in 1943, in a play called *Sodome et Gomorrhe* (Sodom and Gomorrha). This performance brought him several offers to appear in films. Within five years, Philipe's screen appearances had made him an international star. Philipe joined the Théâtre Nationale Populaire in 1951, and he appeared in many memorable stage productions. In 1957, he became president of the French actors' union.

**Gérard Philipe**

**Philippi** was a city in Macedonia. It stood about 13 kilometres from the Aegean coast, near what is now the Greek city of Kavalla. King Philip II of Macedon founded the city in 357 B.C. The city became an important gold-mining centre. Mark Antony and Octavian (later Augustus) defeated two of Julius Caesar's assassins, Brutus and Cassius, at Philippi in 42 B.C. Octavian later made Philippi a colony for Antony's supporters who had been expelled from Italy. Philippi was the first city in Europe to be visited by St. Paul. It flourished until about A.D. 600.

See also **Philippians, Epistle to the.**

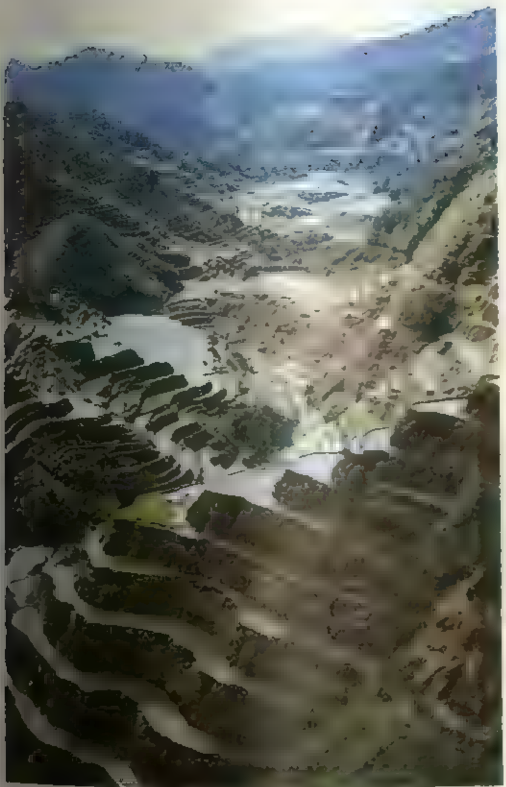
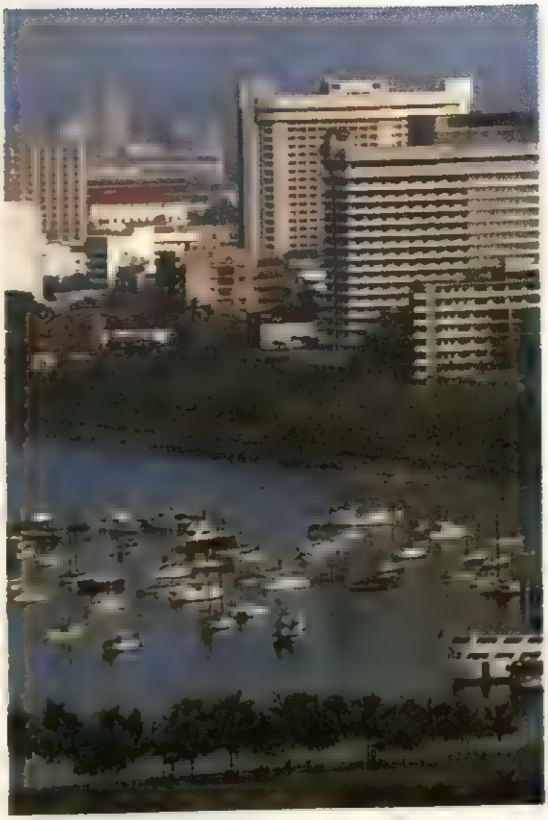


**Philippi** was a city in Macedonia. The city's basilica, *above*, dates back to the A.D. 500's.

**Philippians, Epistle to the,** is the 11th book of the New Testament of the Bible. It is a letter from the apostle Paul to the Christians in Philippi, in what is now northern Greece. Many scholars doubt that Paul wrote the letter in its present form. They believe it consists of three smaller letters from Paul to the Philippians that were combined by a later editor. If Paul wrote the letter in its present form, he did so while in prison, probably in Rome, in about A.D. 60. In the Epistle, Paul thanks the Philippians for sending him money. He warns them not to observe the Jewish law and urges them to be at peace with one another.

**Philippics.** See **Demosthenes.**

**Philippine Trench.** See **Philippines** (Land and climate).

**Traditional and modern ways of life** contrast greatly in the Philippines. In northern Luzon, *left,* farmers grow crops on mountain terraces built more than 2,000 years ago by Malay immigrants. In Manila, the capital and largest city, *right,* modern buildings rise above a bay.

# Philippines

**Philippines** is an island country in the southwest Pacific Ocean. Its official name is the Republic of the Philippines. The Philippines consist of about 7,100 islands and islets, many of which are so small that they have no name. The islands lie in the tropics, about 100 kilometres from the coast of mainland Asia. They have a total area of 300,000 square kilometres. The two largest islands, Luzon and Mindanao, make up about two-thirds of the total area. Most of the land is mountainous, and volcanoes are dotted throughout the country. Most settlements are on the plains between the mountains and along the coasts. The busy port of Manila, on Luzon, is the capital and largest city. Its metropolitan area contains about a tenth of the country's population.

The people of the Philippines are called *Filipinos.* They include a few *Negritos* (pygmies) but most Filipinos are descended from migrants from Indonesia and Malaysia. These people formed small communities throughout the islands, each with its own culture, giving the Philippines a wide variety of languages, customs, and ways of life.

In 1521, the explorer Ferdinand Magellan led a Spanish expedition to the Philippines. General Miguel López de Legazpi founded the first Spanish settlement on the island in 1566 (see **Legazpi, Miguel López de**). This began a long period of Spanish rule. The islands were named after Philip II of Spain. The Spaniards introduced Christianity to the islands. Today, more Christians live in the Philippines than in any other Asian country. In the 1890's there were several revolts against Spanish rule and on June 12, 1898, nationalist leaders declared the Philippines independent. Meanwhile, war had broken out between Spain and the United States of America (U.S.A.) in April 1898. The U.S. fleet defeated the Spaniards in the Battle of Manila Bay on May 1. In December 1898, Spain and the U.S.A. signed a peace treaty, and the U.S.A. took control of the country. The U.S.A. made the Philippines a self-governing commonwealth in 1935. The Japanese occupied the islands from 1942 to 1945, but the U.S.A. regained control in 1945. The Philippines became fully independent on July 4, 1946.

Since 1946, the country has developed many of its rich resources, including its rainforests, fertile soils, vast fishing grounds, and its minerals, which include oil and natural gas. But economic development has caused many problems. Most metallic minerals are exported as raw materials, instead of being processed in the Philippines. The forests are being cut down so quickly that

## Philippines in brief

**Capital:** Manila.
**Official languages:** Filipino and English.
**Official name:** *Republika ng Pilipinas* (Republic of the Philippines).
**Largest cities:** (1990 census)
Manila (1,598,918; Manila metro area 7,561,413)
Quezon City (1,666,766)
Davao (1,055,016)
Cebu (610,417)


**The Philippine flag and coat of arms** feature blue for noble ideals, red for courage, and white for peace. The sun represents independence, and the stars stand for the three main groups of islands. The coat of arms bears the Filipino words meaning *One Spirit, One Nation.* Former Western rule is symbolized by an eagle for the United States and a lion for Spain. The flag was adopted in 1898, and the coat of arms in 1946.

### Land and climate

**Land:** Consists of group of more than 7,000 islands in Pacific Ocean off coast of Southeast Asia. Indonesia lies to the southwest; China and Taiwan to the north and northwest; Vietnam to the west. Two largest islands are Luzon in the north and Mindanao in the south. Between Luzon and Mindanao lie a group of medium-sized islands called Visayas. Many mountainous areas in Luzon and Mindanao.


**Area:** 300,000 km². *Greatest distances*—north-south 1,854 km; east-west 1,107 km. *Coastline*—17,500 km.
**Elevation:** *Highest*—2,954 m (Mount Apo on Mindanao). *Lowest*—sea level.
**Climate:** Hot and moist all year round, but cooler in the highland areas. Hottest months March to May.

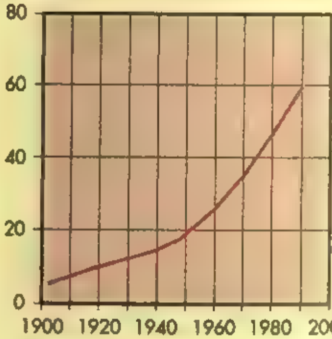
### Government

**Form of government:** Democratic republic.
**Chief executive:** President (elected to 6-year term).
**Legislature:** Congress of two houses: 24-member Senate and 250-member House of Representatives.
**Political subdivisions:** 73 provinces plus metropolitan Manila.

### People

**Population:** *1996 estimate*—70,559,000; *1990 census*—60,546,320. *2001 estimate*—77,385,000.
**Population density:** 235 people per km².
**Distribution:** 54% rural, 46% urban.
**Major ethnic/national groups:** Filipinos form a group of closely related peoples of Malay origin. About 6% of the population consists of native tribal peoples. About 1% of Chinese descent. Some Filipinos are partly of Spanish or American descent.
**Major religions:** 85% Roman Catholic, 10% other Christian, 3% Muslim, 2% Animist.

### Population trend




| Year | Population |
|---|---|
| 1903 | 7,635,000 |
| 1918 | 10,314,000 |
| 1939 | 16,002,000 |
| 1948 | 19,234,000 |
| 1960 | 27,088,000 |
| 1970 | 36,684,000 |
| 1980 | 48,098,000 |
| 1990 | 60,546,000 |

### Economy

**Chief products:** *Agriculture*—rice, maize, coconuts, sugar cane, bananas, pineapples, cassava, pigs, chickens and eggs. *Forestry*—Philippine mahogany. *Manufacturing*—processed foods and beverages, electrical and electronic goods, chemicals and pharmaceuticals, clothing and textiles, petroleum products. *Mining*—copper, gold, nickel, coal.
**Money:** *Currency unit*—Philippine peso. One peso = 100 sentimos.
**Gross domestic product:** *1994 total GDP*—U.S. $14,320,000,000. *1994 GDP per capita*—U.S. $216.
**Foreign trade:** *Major exported goods*—electrical and electronic equipment, coconut products, clothing, bananas, copper. *Major imported goods*—petroleum, machinery, chemicals. *Main trading partners*—United States, Japan, Hong Kong, Germany.

Mindanao fishing village

## Highlights

### Central Luzon

**Manila.** Capital and largest city in Philippines. For highlights, see **Manila** (Manila in brief).

**Quezon City.** Former capital, near Manila. Stately government buildings, sprawling campus of University of the Philippines, 25,000-seat Araneta Coliseum.

**Corregidor.** Island in Manila Bay. U.S. fortress fell to Japanese forces in 1942. War artifacts still there.

**Pagsanjan Falls.** Scenic tropical gorge with 100-metre waterfalls. River trips in *barcas* (dugout canoes) feature swift rapids.

**Lake Taal.** Huge lake is centre of extinct volcano. New volcano forms an island in Lake Taal; crater and a lake inside new volcano. Lake Taal and its volcano often viewed from Tagaytay on a high ridge at north side of the lake.

**Las Piñas.** Small town near Lake Taal; church bamboo organ, made in early 1800's, has more than 800 bamboo pipes.

### Northern Luzon

**Mountain Provinces** (north-central Luzon). Beautiful highlands area; rugged mountains, caves, hot springs, waterfalls. Home of Igorots, Ifugaos, Kalingas, and other mountain tribes, some of whom maintain traditional life styles. New town of Banaue, Ifugao tribes mountainside rice terraces—some constructed 2,000 years ago—are architectural wonders. Other terraces near commercial city of Bontoc. Village of Sagada known for burial caves.

**Baguio.** Mountain resort city known as *summer capital of the Philippines.* Cool mountain air, pine forests nearby. Gardens; some cool-weather crops grown in area, especially strawberries. Colourful market, Bell Church (mixture of Buddhism, Taoism, Confucianism, and Christianity), faith healers, twin-spired Baguio Cathedral, panoramic view at Mines View Park, Easter School of Weaving (demonstrates traditional weaving of Igorot people).

**Provinces of Ilocos Norte and Ilocos Sur** (northwestern Luzon). Beautiful beaches and countryside; well-preserved Spanish churches, especially in Paoay, Laoag, and Vigan.

**La Union Province.** Palm-fringed beaches, brilliant hibiscus blossoms and flame trees. San Fernando is capital of province; bustling port, excellent fresh seafood. Nearby San Juan known for pottery.

**Hundred Islands National Park.** In Lingayen Gulf. Cluster of tiny islands with white beaches, coral reefs, caves.

### Southern Luzon

**Mayon Volcano.** Still active volcano with symmetrical cone; famous national symbol.

**Legazpi.** Waterfront city near Mayon Volcano. Altar at St. Raphael Church is huge chunk of volcanic rock.

**Cagsawa Church.** Steeple alone remains above ground; eruption of Mayon Volcano in 1814 buried three villages and killed about 1,200 people.

**Lake Buhi.** Home to *sinarapan,* tiny fish not much larger than grain of rice. Fishers net them, press hundreds into flat squares, and dry the square "fish cakes" in the sun.

**Mindoro.** Large, picturesque island south of Luzon. Fine coral beaches at Puerto Galera.

**Marinduque.** Small island east of Mindoro. Dramatic, colourful Moriones Festival at Easter.

### The Visayas

**Cebu City.** Commercial and educational centre of Visayas, on Cebu Island. Substantial Chinese population. Oldest Philippine city founded by Spaniards (1565). Natives converted to Christianity in late 1500's; fragments of explorer Ferdinand Magellan's cross now part of newer cross, city's premier landmark. Fort San Pedro oldest Spanish fort in country. Colon Street, heart of central Cebu, oldest street in country. Island handicrafts and agriculture at festive Carbon Market. Striking Taoist Temple. Mosaics made of butterfly wings at Jumalon Art Gallery.

**Mactan Island.** Small island near Cebu City. Monument commemorates spot where Magellan died. Nearby monument honours Lapu-Lapu, local chief who killed Magellan. Maribago, one of numerous beautiful beach resorts, is a centre of Cebu's noted guitar-making industry.

**Bohol.** Island with extensive coral reefs, coconut palms, scenic beaches. "Chocolate Hills"—hundreds of brown hills that resemble chocolate drops (actually brown only in the dry season, when grass cover turns brown).

**Leyte.** Site of first landing of U.S. troops when they recaptured Philippines from Japanese during World War II. Sohoton National Park: waterfalls, underground streams, caves with glittering stone formations.

**Negros.** Major sugar-producing island. Old steam engines used in sugarcane harvest.

**Panay.** Densely populated island; many old Spanish churches. Iloilo main city and important port. Frenzied Ati-Atihan festival in Kalibo in mid-January.

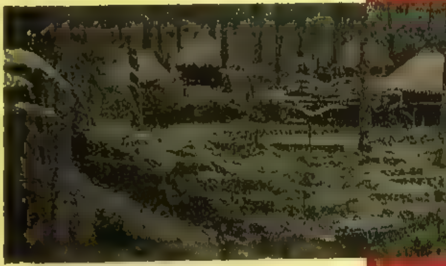
**Romblon Province.** Group of about 20 islands and islets known for valuable marble deposits (between Panay, Mindoro, and Masbate).

**Palawan.** Country's third largest island, thinly populated. Mountainous jungle, rich fishing areas, rare plants and animals (civets, chevrotains, badgers), wild natural scenery.

**Volcanic Lake Taal**

**Mindanao.** Second largest island. Highest mountains in Philippines. Plantations of pineapples and other fruit. Abundance of minerals. Valuable forests. Many Muslims, especially in western part of island and in Solo Archipelago. Also many tribal groups in highlands.

**Davao.** Country's second-largest city. Wide variety of fruit. Nearby Mount Apo highest in country. Lon Wa Temple largest Buddhist temple on island.



**Forest village**

**Cagayan de Oro** Commercial and educational centre. One of world's largest plantations nearby. Huluga Caves—site of human habitation about 2500 B.C.

**Iligan.** Industrial city. Nearby Maria Christina Falls the highest in country, site of hydroelectric plant.

**Zamboanga.** Mixture of Christian and Muslim influences. Bustling port city; trade extends to Borneo; many kinds of boats and canoes, lively Barter Trade Market, gardens with tree-house at Pasonanca Park.

**Sulu Archipelago.** Group of islands to the southwest of Mindanao. Numerous tribes—some seafaring, some in village dwellings built on stilts over water.

**Fishing boats, southern Luzon**

**Negritos** are a small, dark-skinned people descended from the earliest known inhabitants of the islands.

they will vanish completely in 50 years unless conservation measures are taken. Another problem is the rate of population growth, which is one of the world's highest.

## People

**Population and ancestry.** For the Philippines' total population see the *Philippines in brief* tables at the start of this article. The Philippines is one of the world's most populous countries. About half the people live on Luzon, the largest island, with the greatest concentration in the metropolitan area of Manila.

In recent years, the population has been increasing at an annual rate over 2 per cent a year. This is one of the highest rates in the world. More than half of the people are under 20 years of age. The population is divided equally into men and women, though boys are in the majority among the very young.

Archaeological evidence indicates that the earliest known people in the Philippines lived in the Tabon caves on Palawan more than 400,000 years ago. The earliest known migrants to the islands were the Negritos, who arrived about 50,000 years ago. But most modern Filipinos are descended from Indonesians and Malays, who began to settle in the Philippines about 3000 B.C. The rest of the population is descended from recent immigrants. They include Chinese, Europeans (especially Spaniards), Americans, Indians, and Japanese. The mix of peoples has enriched Philippine culture and created a unique blend of Eastern and Western traditions.

The Philippines contains more than 70 ethnic and language groups. The largest groups live on the lowlands. Most of them are Christians and they form the mainstream of Filipino society and culture. These peoples include the Tagalog group, who are concentrated in central and southern Luzon, especially in Manila, and also on the nearby islands of Mindoro and Marinduque. Other major groups include the Ilocanos in northern Luzon, the Bicolanos of southern Luzon, and several groups on the central Visayan Islands.

Minority peoples form small and highly dispersed communities in the mountainous regions of the Philippines. Most of them are not Christians, and their way of life differs sharply from that of most Filipinos. Such groups include the Caraballo tribes, the Cordillera peoples, the Dumagats, the Mangyans, the Mindanao Manobos, the Negritos, and Palawan hill tribes. Other cultural minorities include Filipino Muslim and Chinese communities. Over the years, intermarriage between the various groups has promoted both the assimilation and the integration of minority peoples into Filipino society.

Filipinos are divided into three social classes. The lower class makes up more than half of the population. It includes blue-collar workers, small farmers, fishing peoples, semiskilled and unskilled labourers, and the landless. The middle class, which forms more than a third of the population, contains professional people, farmers with medium-sized holdings, business people, government officials, and teachers. The small upper class includes major landowners, leading professionals, big business people, and top public officials.

**Languages.** According to the 1987 Constitution, the two official languages are Filipino and English. Filipino, which was spelled *Pilipino* before 1987, was designated the national language in the 1987 Constitution. The 1935

**Philippines population**

**Manila Cathedral,** in the old part of the city, dates from the 1950's. War or earthquake destroyed earlier cathedrals.

constitution stated that the national language should be based on one of the local languages. The one chosen was Tagalog, a language widely spoken on Luzon. Later constitutions made provisions for the further development and enrichment of the national language. Today, Filipino is still based largely on Tagalog, but it continues to absorb words from other local and foreign languages. In the late 1980's, a survey revealed that almost all Filipinos understand Tagalog, and more than 80 per cent can speak, read and write it.

Filipino is a required subject in both state and private primary schools, at both primary and secondary levels. Teachers are trained to use Filipino in the classroom. Many textbooks and other educational materials are published in the national language as well as in English. Official government publications are also produced in Filipino.

The government hopes that the use of Filipino will help to unify the people, who may speak one of the 100 or so local languages and dialects. The major local languages are Tagalog, Bikol, Cebuano, Hiligaynon, Iloko, Pampangan, Pangasinan, and Samar-Leyte (Samarnon). The local languages are all Malayo-Polynesian in origin. But they have incorporated much from foreign languages such as Arabic, Chinese, English, Hindi, and Spanish.

More than half of the people understand English. Primary and secondary schools, especially in the private sector, conduct many classes in English. Colleges and universities require students to pass written examinations or proficiency tests in English, because it is used by teachers in higher courses. English is widely used for economic and political subjects. Most Filipinos speak at least two languages. They learn the local languages or the languages of their parents in early childhood and then they study Filipino and often English at school. When the family moves to another area, they may learn even more languages. A few people also speak Arabic, Chinese, or Spanish.

**Rural life.** About three-fifths of the people live in rural areas, although the proportion of people in the towns and cities is steadily increasing. Many rural communities are in the lowlands, especially on national or provincial roads. Many are supplied with electricity, health services, drinkable water, and transportation and communication, but these services are usually inadequate. Rural settlements include roadside *barrios* (villages), *pablaciones* (small towns founded by the Spaniards), and *barangays* (small, independent villages).

The people in most rural areas make their living by farming, though some are employed in fishing, forestry, and mining. Most either own or lease smallholdings, or they are the tenants of other landowners. Women in

**A fishing village** has small houses that stand close together. Fishing is an important industry in the Philippines. Anchovies, mackerel, sardines, scad, tuna, and other fishes are caught in the waters surrounding the country's islands.

**A residential suburb,** *left,* is part of the huge metropolitan area of Manila. The Manila metropolitan area is one of the largest in the world.

rural areas usually help to farm the land or rear poultry and pigs. Landless people work as labourers.

Most rural communities consist of clusters of small houses, built close to one another. The houses have wood or bamboo walls and floors, and roofs made of thatch or corrugated iron. Most homes contain one or two rooms. They are often raised above the ground, and the space underneath them is often used for storage.

Most families in rural communities are closely related to one another. Most marry early and have large families. The birth rate is about 20 per cent higher than in urban areas, but is offset by higher levels of infant and child mortality. Rural families have only about half the average income of urban families.

Rural people are strongly influenced by traditions and also by a sense of neighbourliness, loyalty to their family and community, and mutual assistance. They consider it important to keep in harmony with nature and with their fellows. Most people obey authority and rely on fate or supernatural forces when they are in difficulty. Modern medical services are used alongside traditional medicine practised by herbalists and faith healers.

An important event is the *fiesta,* which is celebrated once a year in honour of the community's religious patron or patroness. At the fiesta, relatives and friends from separate communities renew their ties and exchange views. Elaborate dishes are served to guests during fiestas. One popular dish is *lechon* (roasted pig). *Adobo* consists of chicken and pork cooked in soy sauce and vinegar. Beer and *tuba* (fermented coconut wine) are popular alcoholic beverages.

The rural population faces many problems, including low productivity on farms, underemployment, shortage of cash, and inadequate credit and marketing facilities. In upland areas, many people suffer extreme poverty and periodic political unrest. In recent times, the government has introduced rural development programmes. It has given land to the landless, extended agricultural loans and services, promoted modern agricultural techniques, and built irrigation systems. The programmes also include the development of local rural organizations, aimed at increasing self-help.

**Urban life.** About two-fifths of the population live in cities and towns. Most of these settlements are planned in the same style as Spanish cities. In the centre is a *plaza,* around which the main church, schools, government office, and business establishments are clustered. The plaza is the centre of city life.

The entire Manila metropolitan area is part of *Metro-Manila,* the leading urban centre in the Philippines. Metro-Manila is also known as the National Capital Region. This region includes four cities and 13 municipalities, and its people make up almost one-third of the total urban population in the Philippines. The density of population in the National Capital Region is more than 12,000 per square kilometre, compared to about 200 per square kilometre in other cities. Cebu in the Visayan Islands and Davao in Mindanao are the second and third largest metropolitan areas in the Philippines.

The cities, especially Manila, have a wide range of economic, educational, recreational, religious and other facilities, which attract migrants from surrounding rural areas. Many people move to the cities in search of jobs. Students go there for high-quality education. Together they account for a large proportion of the annual five per cent increase in the urban population.

More than half of the people in the cities are known as the urban poor. Most of them are migrants, with large, young households. They live in sprawling slums and squatter neighbourhoods in the inner cities. The slums are overcrowded and the people live in squalor. Many slums and squatter areas are situated on undeveloped public or private properties. Others have grown up on marginal land, such as the sides of creeks, waste dumps, and along rail tracks. The urban poor live in shacks made from discarded cardboard and metal. Some dwellings have electricity supplies, but they lack clean drinking water, waste disposal facilities, and ventilation.

Families belonging to the urban middle class live in rented flats or in family-owned bungalows built of wood and concrete. These homes are situated in government or private housing projects, which are called *subdivisions.*

Wealthy families live in large, beautiful homes in first-class subdivisions surrounded by high walls and guarded by hired security men. They send their children to exclusive private schools.

Filipinos, especially in lower-income neighbourhoods, value close personal, family, and community ties. Family and kinship ties in the upper-income groups are limited to major events, such as birthdays and weddings. City people are generally more politically aware and active than rural Filipinos. Many city people are better educated, more Westernized in their beliefs and practices, and more open to the changes brought by modernization.

Men hold most positions of authority in business and industry. But many women now work in the professions. A growing number of women also work in textiles or electronics factories.

**Clothing.** Most Filipinos wear clothes similar to those worn in Western countries. In the dry season, most people dress in cotton. On rainy days, they also wear thick jackets or sweaters. Women, especially those from the upper class, have a keen sense of fashion. Teenagers often wear jeans, T-shirts, and casual canvas shoes with rubber soles.

At weddings and other formal occasions, Filipino men often wear the *barong tagalog,* a beautifully embroidered, long-sleeved shirt woven from pineapple fibre, raw silk, or cotton. A short-sleeved variation of this shirt, called the *polo barong,* is often worn at work. For formal wear, Filipino women sometimes wear dresses inspired by ethnic costumes. They include the *balintawak,* which has a wide collar and puffed sleeves, and the *terno,* which consists of a blouse with butterfly sleeves and collar scarf, and a full, ankle-length skirt.

Filipinos in Muslim and minority mountain communities have their own, mostly handwoven, colourful costumes. These people also wear such accessories as beaded necklaces and bracelets, armbands, and turbans or other headdresses.

**Recreation.** Basketball, the national sport, is played by boys, girls, and men in school, in their neighbourhoods, and on professional courts. Filipino families of all social classes enjoy watching professional basketball games on television.

Men in rural areas watch cockfighting, and often gamble on the outcome of the fights. Children enjoy kite-flying, *sipa* (a kicking game), top-spinning, and hide-and-seek.

Many Filipino families spend their weekends visiting relatives, strolling through parks, holding picnics on beaches, and eating in restaurants. Many parents in the cities take their children to the cinema, or stroll through the large shopping complexes.

**Education.** The Philippines has one of the highest literacy rates in Asia. About 90 per cent of the country's people can read and write, and about 98 per cent of school-age children now attend school. The Philippines has about 1,300 preschool institutions, more than 35,000 state primary and secondary schools, and more than 400 colleges and universities. There are also about 6,100 private schools.

The academic life of many students starts with six years of primary school education, followed by four years of secondary school education, and four to five years of college education. Altogether, students spend on average 14 years at school and college, ending when they are 21.

Most Filipino families regard education as a means of improving their lot in life. But, although they are keen to send their children to school, the number of dropouts from school is high and it increases among the older children. Only 67 per cent of Filipino children who enter Class 1 manage to complete their time at primary school. Of those that do complete primary education, not all are able to continue and complete secondary school and a college education.

The majority of college students take commercial and business management courses at private and religious

**Sipa** is a game that is popular with men and boys in the Philippines. They play with a small ball, kicking it across a net on a court about the size of a tennis court. The game requires speed, agility, and good ball control.

**Public primary schools** provide six years of free education for Philippine children. The Filipinos value education highly, and about 30 per cent of pupils go on to college.

schools. The oldest university is the Santo Tomas University. The biggest is the Polytechnic University of the Philippines. Both are in Metro-Manila.

**Health.** The average life expectancy at birth is rising annually by about 4 months. It now stands at 64 years for men and 66 years for women. The people of Manila generally have life expectancies greater than the national average. The main causes of death are pneumonia, heart disease, and tuberculosis.

Improvements in the health of the people are the result of several factors. First, living conditions have improved because of the nationwide projects concerned with sanitation and safe water supply. Health care and health and nutrition services have improved greatly, and communicable diseases, especially among the young, have decreased through the development of primary health care, maternal and child care, and immunization.

**Religion.** Filipinos are free to choose the form of worship they wish to follow. But, for historical reasons, most people in the Philippines are Christians, and the country is the only predominantly Christian country in Asia. About 80 per cent of Filipino Christians are Roman Catholic. The others follow several groups, the largest of which are the Philippine Independent Church, known as Aglipayan, the *Iglesia ni Cristo,* the Methodist Church, and the United Church of Christ (see **Christianity**).

About 5 per cent of Filipinos are Muslims, about 2 per cent follow local animist religions, and there are a few thousand Buddhists (see **Animism; Buddhism; Islam**).

Foreigners introduced most religions to the Philippines. As a result, *indigenous* (local) beliefs have merged with the doctrines of imported religions. For example, many Filipino Christians still believe in ghosts and spirits, and patronize fortune tellers.

The Filipino churches not only carry on religious conversion, but they also organize services to help the poor. Many Christian groups teach people skills, conduct literacy classes, set up children's feeding centres, provide medical care, provide free medicines, and develop community organizations.

Most religious institutions are short-staffed. For example, the Roman Catholic Church has too few clergy to make regular visits to rural communities. To tackle this problem, the church has set up basic Christian communities, especially in rural areas and among the urban poor. Each community consists of about 25 families. Members of the community meet to study the Bible under a lay leader, and to discuss ways to solve common problems.

**Arts.** The Philippines has produced many gifted artists, some internationally acclaimed, in the fields of literature, painting, and the performing arts—music, theatre, and dance.

Philippine literature has appeared in local dialects, Filipino, English, and Spanish. Early Filipino writing consisted largely of proverbs, legends and epics that told of birth, death, love, war, and heroism. During the colonial periods, Filipino writers used literature as a means of

**Traditional costumes** are made from colourful handwoven materials. Beads and headdresses go with them.

effecting social change. For example, José Rizal's novel *El Filibusterismo* (The Subversive) and *Noli Me Tangere* (Touch Me Not), and Francisco "Balagtas" Baltazar's poem, "Florante at Laura," criticized Spanish abuse of authority. Popular contemporary Filipino writers and poets include Manuel Arguilla, Renato Constantino, N. V. M. Gonzales, Amado Hernandex, Nick Joaquin, and Jose Garcia Villa.

Many people consider that Juan Luna, whose work made the Philippines known to the world in the 1800's, was the greatest Filipino painter. His best-known works are *The Blood Compact,* which depicts the pledge of friendship between the Spanish explorer Miguel López de Legazpi and the Bohol chief Sikatuna, and *Spoliarium,* which shows the cruelty and horror of the Roman battle of the gladiators. Fernando Amorsolo was known in the 1900's for his portraits and paintings of rustic life. Popular modern painters include Carlos "Botong" Francisco, José Hernandez, Ang Kiukok, and Vicente Manasala. Guillermo Tolentino is considered to be the greatest of all Filipino sculptors.

In the past, Filipinos had music for every occasion. Islamic and tribal groups have preserved such traditional types of music. They play varied wind, stringed, and percussion instruments made from local materials. Contemporary Filipino music combines Eastern and Western musical traditions. Popular forms of music include the *kundiman* (love song); the *harana* (serenade); folk songs, such as "Bahay Kubo"; and ballads, such as "Kapantay ay Langit".

Filipino musicians who have achieved international fame include Freddie Aguilar, José Mari Chan, and the child singer Josephine "Banig" Roberto. Also internationally known are actress Lea Salonga, and ballet dancers Maniya Barredo, Lisa Macuja, and Anna Villadolid.

### Land and climate

The Philippines is a largely mountainous country, with narrow strips of lowland along the coast and some broad inland plains, especially on the islands of Luzon and Panay. Volcanic mountains rise on most of the country's largest islands, and many of the volcanoes are still active. The highest mountain, Mount Apo on Mindanao, is a dormant volcano that towers 2,954 metres above sea level. Violent earthquakes occur frequently on the islands.

The islands of the Philippines began to form about 50 million years ago as a result of the buckling of the Earth's crust and volcanic eruptions. They are part of a huge belt, called the *Ring of Fire,* that encircles the Pacific Ocean. Throughout this belt, volcanic eruptions and earthquakes are common. Many scientists believe that the eruptions and earthquakes are caused by movements of the rigid plates that make up the Earth's hard outer shell. Most volcanoes and the most severe earthquakes occur near the edges of the plates. Geologists call this theory plate tectonics (see **Plate tectonics**).

The Philippine Trench, one of the greatest ocean depths, is off the northeast coast of Mindanao. It reaches a depth of 10,439 metres below the surface of the Pacific. Scientists believe that the trench forms the boundary between two plates which are pushing against each other. One plate is bending downwards beneath the other. Deep down beneath the crust, the

**Mayon Volcano** is an active volcano near Legazpi, in Albay Province, southeastern Luzon. It is almost perfectly cone-shaped. Weathered volcanic ash from past eruptions has given the surrounding area rich soil where crops thrive.

## Regional divisions

The National Census and Statistics Office of the Philippines has divided the Philippines into 13 geographical regions including the National Capital Region.

### Region 1-The Ilocos Region

*Provinces:* Abra, Benguet, Ilocos Norte, Ilocos Sur, La Union, Mountain Province, Pangasinan
*Cities:* Baguio, Dagupan, Laoag, San Carlos
*Regional Centre:* San Fernando, La Union
*Area:* 21,568 km²
*Population:* 4,133,684

### Region 2-The Cagayan Valley

*Provinces:* Batanes, Cagayan, Ifugao, Isabela, Kalinga-Apayao, Nueva Viscaya, Quirino
*Regional Centre:* Tuguegarao, Cagayan
*Area:* 36,403 km²
*Population:* 2,712,696

### Region 3-Central Luzon

*Provinces:* Bataan, Bulacan, Nueva Ecija, Pampanga, Tarlac, Zambales
*Cities:* Angeles, Cabanatuan, Olongapo, Palayan, San Jose
*Regional Centre:* San Fernando, Pampanga
*Area:* 18,231 km²
*Population:* 5,862,990

### Region 4-Southern Tagalog

(National Capital and Southern Luzon)
*Provinces:* Batangas, Aurora, Cavite, Laguna, Marinduque, Oriental Mindoro, Occidental Mindoro, Palawan, Quezon, Rizal, and Romblon.
(The National Capital Region, of which Metro-Manila is a part, is classified as Region 4-A).
*Cities:* Batangas, Caloocan, Cavite, Lipa, Lucena, Manila, Pasay, Puerto Princesa, Quezon City, San Pablo, Tagaytay, Trece Martires.
*Regional Centre:* Manila
*National Capital Area:* 636 km²
*Population:* 7,561,413
*Southern Luzon Area:* 46,924 km²
*Population:* 7,691,855

### Region 5-The Bicol Region

*Provinces:* Albay, Camarines Norte, Camarines Sur, Catanduanes, Masbate, Sorsogon.
*Cities:* Iriga, Legazpi, Naga
*Regional Centre:* Legazpi City
*Area:* 17,633 km²
*Population:* 4,197,973

### Region 6-Western Visayas

*Provinces:* Aklan, Antique, Capiz, Guimaras (subprovince), Iloilo, Negros Occidental
*Cities:* Bacolod, Bago, Cadiz, Iloilo, La Carlota, Roxas, San Carlos, Silay
*Regional Centre:* Iloilo City
*Area:* 20,223 km²
*Population:* 5,438,994

### Region 7-Central Visayas

*Provinces:* Bohol, Cebu, Negros Oriental, Siquijor.
*Cities:* Bais, Canlaon, Cebu, Danao, Dumaguete, Lapu-Lapu, Mandawe, Tagbilaran, Toledo
*Regional Centre:* Cebu City
*Area:* 14,951 km²
*Population:* 4,446,456

### Region 8-Eastern Visayas

*Provinces:* Eastern Samar, Leyte, Northern Samar, Southern Leyte, Western Samar
*Cities:* Calbayog, Ormoc, Tacloban
*Regional Centre:* Tacloban City
*Area:* 21,432 km²
*Population:* 3,242,836

### Region 9-Western Mindanao and Sulu

*Provinces:* Sulu, Zamboanga del Norte, Zamboanga del Sur, Tawi-tawi, Basilan
*Cities:* Basilan, Dapitan, Dipolog, Pagadian
*Regional Centre:* Zamboanga City
*Area:* 18,685 km²
*Population:* 3,060,825

### Region 10-Northern Mindanao

*Provinces:* Agusan del Sur, Agusan del Norte, Bukidnon, Camiguin, Misamis Occidental, Misamis Oriental, Surigao del Norte
*Cities:* Butuan, Cagayan de Oro, Gingoog, Oroquieta, Ozamis, Tangub
*Regional Centre:* Cagayan de Oro City
*Area:* 28,328 km²
*Population:* 3,437,549

### Region 11-Southern Mindanao

*Provinces:* Davao del Norte, Davao del Sur, Davao Oriental, South Cotabato, Surigao del Sur
*Cities:* Davao, General Santos
*Regional Centre:* Davao City
*Area:* 31,693 km²
*Population:* 4,132,019

### Region 12-Central Mindanao

*Provinces:* Lanao del Norte, Lanao del Sur, Maguindanao, Cotabato, Sultan Kudarat
*Cities:* Iligan, Marawi, Cotabato
*Regional Centre:* Cotabato City
*Area:* 23,293 km²
*Population:* 2,802,001

## Philippines map index

### Provinces

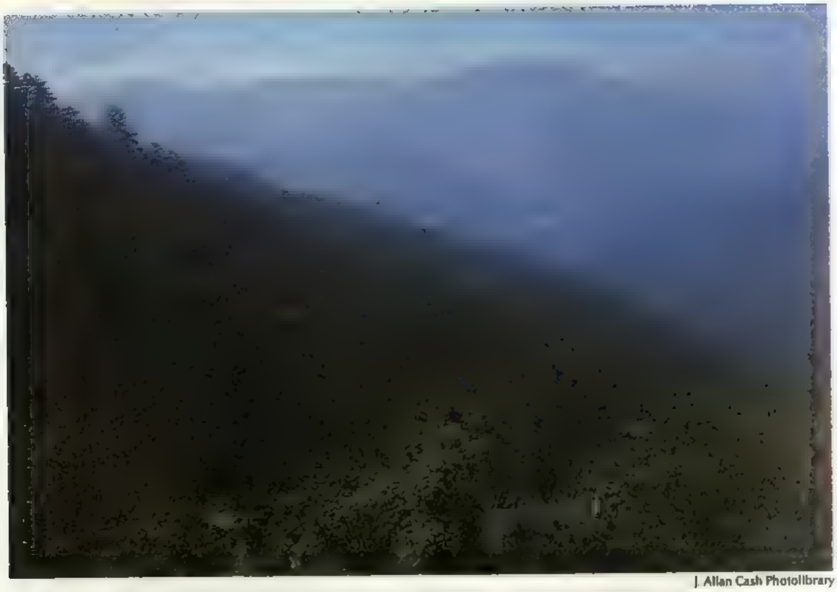
| | | | |
|---|---|---|---|
| Abra | 184,743 | C | 3 |
| Agusan del Norte | 465,458 | H | 6 |
| Agusan del Sur | 420,763 | H | 6 |
| Aklan | 380,497 | F | 4 |
| Albay | 903,023 | E | 5 |
| Antique | 406,361 | G | 4 |
| Aurora | 139,586 | D | 4 |
| Basilan | 243,091 | J | 4 |
| Bataan | 425,803 | D | 3 |
| Batanes | 15,026 | A | 4 |
| Batangas | 1,476,783 | E | 3 |
| Benguet | 485,546 | C | 3 |
| Bohol | 948,315 | G | 5 |
| Bukidnon | 843,959 | H | 6 |
| Bulacan | 1,505,219 | D | 3 |
| Cagayan | 829,974 | B | 4 |
| Camarines Norte | 390,982 | E | 5 |
| Camarines Sur | 1,305,919 | E | 5 |
| Camiguin | 64,247 | H | 6 |
| Capiz | 584,091 | F | 4 |
| Catanduanes | 187,000 | E | 5 |
| Cavite | 1,152,534 | E | 3 |
| Cebu | 2,645,735 | G | 5 |
| Davao | 1,055,016 | J | 6 |
| Davao del Sur | 1,482,648 | J | 6 |
| Davao Oriental | 394,697 | I | 7 |
| Eastern Samar | 329,335 | F | 6 |
| Ifugao | 147,281 | C | 4 |
| Ilocos Norte | 461,661 | B | 3 |
| Ilocos Sur | 519,930 | C | 3 |
| Iloilo | 1,647,486 | G | 4 |
| Isabela | 1,080,341 | C | 4 |
| Kalinga Apayao | 211,775 | B | 4 |
| La Union | 548,742 | C | 3 |
| Laguna | 1,370,232 | E | 4 |
| Lanao del Norte | 614,092 | H | 5 |
| Lanao del Sur | 599,637 | J | 5 |
| Leyte | 1,368,510 | G | 6 |
| Maguindanao | 757,739 | J | 5 |
| Marinduque | 185,524 | E | 4 |
| Masbate | 599,915 | F | 5 |
| Mindoro Occidental | 282,593 | E | 3 |
| Mindoro Oriental | 550,049 | F | 4 |
| Misamis Occidental | 424,365 | H | 5 |
| Misamis Oriental | 865,051 | H | 6 |
| Mountain | 116,535 | C | 4 |
| Negros Occidental | 2,256,908 | G | 4 |
| Negros Oriental | 925,311 | H | 5 |
| North Cotabato | 763,995 | J | 6 |
| Northern Samar | 383,654 | F | 6 |
| Nueva Ecija | 1,312,610 | D | 3 |
| Nueva Vizcaya | 301,179 | C | 3 |
| Palawan | 528,287 | H | 2 |
| Pampanga | 1,532,682 | D | 3 |
| Pangasinan | 2,020,273 | C | 3 |
| Quezon | 1,372,381 | E | 4 |
| Quirino | 114,132 | C | 4 |
| Rizal | 980,194 | D | 4 |
| Romblon | 227,621 | F | 4 |
| Samar | 533,733 | F | 6 |
| Siquijor | 73,790 | H | 5 |
| Sorsogon | 522,960 | F | 5 |
| South Cotabato | 1,072,617 | J | 6 |
| Southern Leyte | 321,940 | G | 6 |
| Sultan Kudarat | 435,905 | J | 5 |
| Sulu | 469,971 | J | 4 |
| Surigao del Norte | 425,978 | G | 6 |
| Surigao del Sur | 452,098 | H | 7 |
| Tarlac | 859,651 | D | 3 |
| Tawitawi | 228,204 | J | 3 |
| Zambales | 562,992 | D | 3 |
| Zamboanga del Norte | 673,774 | J | 4 |
| Zamboanga del Sur | 1,544,157 | J | 4 |

### Cities and towns

| | | | |
|---|---|---|---|
| Agoo | 42,698 | A | 6 |
| Angeles | 236,685 | D | 3 |
| Aparri | 51,635 | B | 4 |
| Bacolod | 364,180 | G | 5 |
| Bago | 122,863 | G | 5 |
| Baguio City | 183,102 | C | 3 |
| Bais | 59,951 | G | 5 |
| Balanga | 51,512 | C | 6 |
| Baler | 24,689 | D | 4 |
| Balimbing | 20,767 | J | 3 |
| Balingasag | 41,506 | H | 6 |
| Baliuag | 89,719 | B | 6 |
| Bambang | 33,663 | A | 7 |
| Bangued | 34,184 | B | 3 |
| Bantayan | 59,893 | F | 5 |
| Basco | 5,729 | A | 4 |
| Basilan | | J | 4 |
| Batangas | 184,970 | E | 3 |
| Bayawan | 78,280 | H | 5 |
| Baybay | 82,281 | G | 6 |
| Bayombong | 39,886 | C | 3 |
| Binalbagan | 52,073 | G | 5 |
| Boac | 41,034 | E | 4 |
| Bogo | 51,083 | G | 5 |
| Bongabon | 39,616 | E | 4 |
| Bonobono | | H | 1 |
| Bontoc | 24,818 | C | 3 |
| Borongan | 44,085 | F | 6 |
| Bulan | 66,450 | F | 5 |
| Butuan | 227,829 | H | 6 |
| Cabanatuan | 173,065 | D | 3 |
| Cabarroguis | 21,793 | C | 4 |
| Cadiz | 119,772 | G | 5 |
| Cagayan de Oro | 339,598 | H | 6 |
| Calamba | 173,453 | C | 7 |
| Calapan | 85,898 | E | 4 |
| Calbayog | 115,390 | F | 6 |
| Caloocan | 601,660 | C | 6 |
| Camiling | 62,716 | A | 6 |
| Carcar | 70,841 | G | 5 |
| Carigara | 38,863 | F | 6 |
| Catarman | 50,965 | F | 6 |
| Catbalogan | 70,470 | F | 6 |
| Cavite | 91,641 | D | 3 |
| Cebu City | 610,417 | G | 5 |
| Cotabato | 127,065 | J | 5 |
| Daet | 66,477 | E | 5 |
| Dagupan | 122,247 | A | 6 |
| Danao | 73,358 | G | 5 |
| Dapitan | 59,046 | H | 5 |
| Datu Piang | 53,311 | J | 6 |
| Davao | 849,947 | J | 6 |
| Digos | 96,806 | J | 6 |
| Dipolog | 79,887 | H | 5 |
| Dumaguete | 80,262 | H | 5 |
| Gapan | 70,489 | B | 6 |
| General Santos | 250,389 | J | 6 |
| Gingoog | 82,582 | H | 6 |
| Gubat | 43,296 | E | 5 |
| Guimba | 73,363 | B | 6 |
| Guiuan | 33,825 | G | 6 |
| Iba | 29,221 | D | 3 |
| Ilagan | 99,120 | C | 4 |
| Iligan | 226,568 | H | 5 |
| Iloilo | 309,505 | G | 4 |
| Iriga | 74,269 | E | 5 |
| Isulan | 56,488 | J | 6 |
| Jolo | 53,055 | J | 3 |
| Jose Panganiban | 44,408 | E | 4 |
| Kalibo | 51,387 | F | 4 |
| Kidapawan | 74,190 | J | 6 |
| Korondal | 108,708 | J | 6 |
| La Carlota | 56,433 | G | 5 |
| La Trinidad | 48,252 | A | 6 |
| Lagawe | 12,437 | C | 3 |
| Laoag | 83,756 | B | 3 |
| Laoang | 42,048 | F | 6 |
| Lapu-Lapu | 146,194 | G | 5 |
| Lebak | 52,428 | J | 5 |
| Legazpi | 121,116 | E | 5 |
| Lemery | 53,932 | C | 6 |
| Lianga | 24,908 | H | 7 |
| Libmanan | 77,565 | E | 5 |
| Lingayen | 77,837 | C | 3 |
| Lipa | 160,117 | E | 4 |
| Lucban | 30,130 | C | 7 |
| Lucena | 150,624 | E | 4 |
| Maasin | 29,062 | G | 6 |
| Malabang | 25,714 | J | 5 |
| Malalag | 27,709 | J | 6 |
| Malaybalay | 94,790 | H | 6 |
| Malolos | 125,178 | D | 3 |
| Mambajao | 25,207 | H | 6 |
| Mamburao | 21,781 | E | 3 |
| Mandaon | 25,670 | F | 5 |
| Mandaue | 168,678 | G | 5 |
| Manila | 1,598,918 | D | 4 |
| Marawi | 91,901 | H | 6 |
| Masbate | 58,714 | F | 5 |
| Mati | 93,023 | J | 7 |
| Muntinglupa | 172,421 | C | 6 |
| Muñoz | 50,356 | A | 6 |
| Naga | 115,329 | E | 5 |
| Nasugbu | 75,515 | C | 6 |
| Olongapo | 193,327 | D | 3 |
| Ormoc | 129,456 | G | 6 |
| Oroquieta | 52,500 | H | 5 |
| Ozamiz | 91,503 | H | 5 |
| Paete | 20,579 | C | 7 |
| Pagadian | 106,307 | J | 5 |
| Pagalungan | 42,495 | J | [illegible] |
| Palayan | 20,393 | B | [illegible] |
| Palompon | 45,745 | C | [illegible] |
| Paniqui | 64,949 | A | [illegible] |
| Pasay | 366,623 | C | [illegible] |
| Pasig | 397,308 | C | [illegible] |
| Pili | 52,481 | E | [illegible] |
| Pinamalayan | 58,777 | E | [illegible] |
| Prosperidad | 51,189 | H | [illegible] |
| Puerto Princesa | 92,147 | G | [illegible] |
| Quezon City | 1,666,766 | C | [illegible] |
| | 32,538 | H | [illegible] |
| Quezon | 38,970 | A | [illegible] |
| Rizal | 29,983 | F | [illegible] |
| Romblon | 36,604 | G | [illegible] |
| Roxas | 40,230 | C | [illegible] |
| Roxas | 103,171 | F | [illegible] |
| Roxas | 112,700 | G | [illegible] |
| Sagay | 51,815 | B | [illegible] |
| San Antonio | 124,529 | C | [illegible] |
| San Carlos | 106,715 | G | [illegible] |
| San Carlos | 84,949 | C | [illegible] |
| San Fernando | 157,851 | B | [illegible] |
| San Fernando | 40,267 | G | [illegible] |
| San Jose | 82,836 | A | [illegible] |
| San Jose | 36,598 | B | [illegible] |
| San Marcelino | 161,630 | E | [illegible] |
| San Pablo | 76,603 | C | [illegible] |
| Santa Cruz | 101,031 | C | [illegible] |
| Silay | 66,148 | H | [illegible] |
| Sindangan | 18,860 | H | [illegible] |
| Siquijor | 72,871 | E | [illegible] |
| Sorsogon | 100,379 | G | [illegible] |
| Surigao | 85,697 | E | [illegible] |
| Tabaco | 57,200 | C | [illegible] |
| Tabuk | 137,190 | F | [illegible] |
| Tacloban | 23,738 | C | [illegible] |
| Tagaytay | 56,363 | C | [illegible] |
| Tagbilaran | 135,440 | J | [illegible] |
| Tagum | 34,351 | H | [illegible] |
| Tandag | 42,926 | H | [illegible] |
| Tangup | 62,656 | H | [illegible] |
| Tanjay | 208,722 | D | [illegible] |
| Tarlac | 31,575 | A | [illegible] |
| Tayug | 119,970 | G | [illegible] |
| Toledo | 35,686 | C | [illegible] |
| Trece Martires | 94,767 | B | [illegible] |
| Tuguegarao | 90,684 | A | [illegible] |
| Urdaneta | 38,574 | B | [illegible] |
| Vigan | 45,523 | E | [illegible] |
| Virac | 442,345 | J | |
| Zamboanga | | | |

Source: 1990 census.

Philippines
Political map
International boundary
Regional boundary
Provincial boundary
Major road
Railway
National capital
Provincial capital
Other city or town
PHILIPPINES
Regions
Cagayan Valley
Southern Tagalog
Northern Mindanao
National Capital Region (Manila)
South China Sea
Philippine Sea
Sulu Sea
Celebes Sea
North
AREA OF INSET MAP
Basco
Batanes
Babuyan Islands
Laoag
Ilocos Norte
Aparri
Vigan
Bangued
Abra
Tabuk
Tuguegarao
Cagayan
Bontoc
Ilagan
Isabela
Roxas
Lagawe
Ifugao
San Fernando
Cabarroguis
Bayombong
Baguio City
Lingayen
San Carlos
Baler
Tarlac
Cabanatuan
Iba
Angeles
Malolos
Olongapo
Manila
Cavite
San Pablo
Lipa
Lucena
Batangas
Quezon
Polillo Islands
Jose Pañganiban
Daet
Catanduanes
Virac
Libmanan
Naga
Pili
Iriga
Tabaco
Albay
Legazpi
Sorsogon
Gubat
Bulan
Boac
Marinduque
Calapan
Mamburao
Pinamalayan
Bongabon
Mindoro Occidental
Mindoro Oriental
Romblon
Masbate
Mandaon
Busuanga I.
Calamian Group
Culion I.
Kalibo
Aklan
Roxas
Antique
Iloilo
San Jose
Bantayan
Cadiz
Silay
Bacolod
Bago
La Carlota
Binalbagan
Negros Occidental
Cebu City
Mandaue
Lapu-Lapu
Carcar
Toledo
Danao
Bohol
Tagbilaran
Bais
Tanjay
Bayawan
Negros Oriental
Dumaguete
Siquijor
Catarman
Northern Samar
Calbayog
Samar
Catbalogan
Borongan
Eastern Samar
Tacloban
Guiuan
Palompon
Ormoc
Leyte
Baybay
Maasin
Surigao
Surigao del Norte
Tandag
Surigao del Sur
Butuan
Agusan del Norte
Gingoog
Balingasag
Cagayan de Oro
Lianga
Prosperidad
Agusan del Sur
Malaybalay
Bukidnon
Davao
Tagum
Davao Oriental
Mati
Digos
Malalag
Davao del Sur
Dapitan
Dipolog
Oroquieta
Misamis Occidental
Misamis Oriental
Sindangan
Ozamiz
Tangub
Iligan
Marawi
Pagadian
Zamboanga del Norte
Molabang
Cotabato
Datu Piang
Kidapawan
Maguindanao
Lebak
Isulan
Sultan Kudarat
Koronadal
General Santos
South Cotabato
Sarangani Islands
Zamboanga
Basilan
Moro Gulf
Jolo
Sulu
Tawitawi
Bongao
Roxas
Cuyo I.
Puerto Princesa
Palawan
Quezon
Brooke's Point
Balabac I.
MALAYSIA
SABAH
Sandakan
Lahad Datu
Bayombong
Bambang
Nueva Vizcaya
Quirino
Aurora
Baler Bay
Dagupan
Urdaneta
Tayug
San Jose
Rizal
Camiling
Paniqui
Muñoz
Guimba
Palayan
Nueva Ecija
Gapan
Bulacan
Pampanga
San Fernando
Baliuag
Zambales
San Antonio
San Marcelino
Subic Bay
Balanga
Bataan
Caloocan
Quezon City
Pasig
Pasay
Laguna de Bay
Corregidor I.
Muntinlupa
Manila Bay
Trece Martires
Calamba
Nasugbu
Tagaytay
Lake Taal
Lemery
Paete
Santa Cruz
Laguna
Lucban
Lamon Bay
Dingalan Bay
Polillo I.
Tayabas Bay
60 Kilometres
50 Miles
1,000 Kilometres
600 Miles



J. Allan Cash Photolibrary

**Pine forests** cover the hills and mountains near the resort town of Baguio, northern Luzon.

descending plate melts, providing *magma* (molten material) that fuels the volcanoes in the Philippines.

The plate movements are not smooth and they occur occasionally in sudden jerks that trigger off earthquakes. The earthquakes sometimes cause destructive tidal waves, which are often called *tsunamis* (see **Tidal wave**). In 1976, huge tsunamis caused by earthquakes struck the coast of eastern Mindanao, causing an estimated 8,000 deaths.

The Philippines has many fine bays and harbours. Large lakes include Laguna de Bay on Luzon and Lake Sultan Alonto (or Lake Lanao) on Mindanao. Many of the rivers flow only in the rainy season, from June to February.

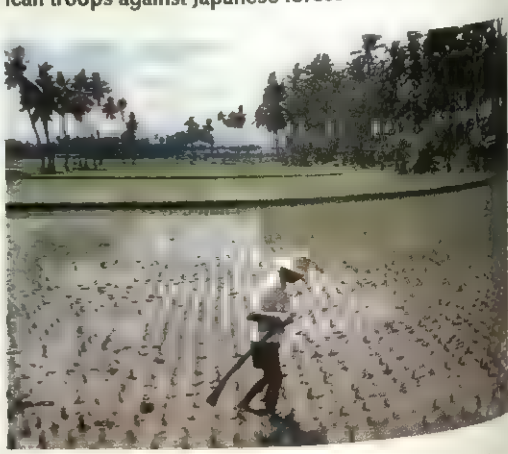
Thick tropical forests cover most of the Philippines. Deforestation in some areas has led to soil erosion. The islands contain a wide variety of plants and animals. Banyan and palm trees grow in the forests. Thick groves of bamboo and about 9,000 kinds of flowering plants grow on the islands.

Wild animals include crocodiles, monkeys, snakes, and many species of tropical birds. *Tarsiers*—small animals with owl-like eyes—live only in the Philippines and Indonesia. The chief domestic animal in the Philippines is the *carabao,* a type of water buffalo that farmers use to pull ploughs, haul loads, and perform various other tasks. The *tamaraw,* a small carabao, is found only on the island of Mindoro.

**The main islands.** The Philippine islands extend about 1,850 kilometres from north to south, and about 1,100 kilometres from east to west. The largest islands are Luzon in the north, and Mindanao in the south. The islands form three groups. Two large islands, Luzon and Mindoro, form the northern group. The central group, called the Visayan Islands or the Visayas, is made up of about 7,000 islands. The main islands in this group are Samar, Negros, Palawan, Panay, Leyte, Cebu, Bohol, and Masbate. The southern group consists of Mindanao and the Sulu Archipelago, a group of about 400 islands that extend south and west toward Borneo. This section describes the 11 largest islands of the Philippines in order of size.

Luzon (area 104,688 km²), is the most important island in the Philippines. Several mountain ranges run generally north-south through northern Luzon. They include the Gran Cordillera Central and the Sierra Madre, in the northeast, between which lies the fertile Cagayan valley. Banawe, northeast of the mountain resort of Baguio in northern Luzon, is famous for its rice terraces. These magnificent stone-walled terraces were built on steep slopes by the Ifugao people over a period of about 2,000 years and are considered to be one of the wonders of the world. Without them, farming would be impossible because there is no level land.

The central plain of Luzon is the country's main rice-producing region. The capital, Manila, stands on the eastern shore of the superb natural harbour, Manila Bay. The island of Corregidor, at the entrance to Manila Bay, was the site of a determined stand by Filipino and American troops against Japanese forces in World War II.



**Rice fields** of central Luzon produce more of this important food crop than any other area of the Philippines.


Philippines terrain map
International boundary
Land region boundary
National capital
Other city or town
Elevation above sea level
Luzon Strait
Batan Islands
Batan I.
Sabtang I.
Balintang Channel
Babuyan I.
Calayan I.
Babuyan Islands
Dalupiri I.
Fuga I.
Camiguin I.
Cape Engaño
Pt. Escarpada
Cape Bojeador
Laoag
North
Palanan Point
Luzon
Cordillera Central
Sierra Madre
Ilagan
Baguio City
Cape Bolinao
Cape San Ildefonso
Cape Encanto
South China Sea
Philippine Sea
15° North Latitude
Angeles
Mt. Pinatubo (Volcano)
Olongapo
Manila
Polillo Islands
Bataan Peninsula
Corregidor I.
Calagua Is.
San Miguel Bay
Yog Point
Catanduanes I.
LUZON AND MINDORO
Lubang Is.
Cape Calavite
Marinduque
Mayon Volcano
San Bernardino Strait
Burias I.
Sibuyan Sea
Bombon I.
Mindoro
Tablas I.
Sibuyan I.
Masbate
Samar
Calamian Group
Culion I.
Semirara Is.
Potol Pt.
Quiniluban Is.
Linapacan I.
Mt. Nangtud 2,117m
Panay
Visayan Sea
Bantayan I.
Cuyo Is.
Camotes Is.
Homonhan I.
Dumaran I.
Naso Point
Guimaras I.
Panay Gulf
Dinagat
Palawan
Puerto Princesa
VISAYAN ISLANDS
Negros
Cebu City
Bohol
Panaon I.
Siargao I.
Bucas Grande I.
Cagayan Is.
Panglao I.
Siquijor I.
Camiguin I.
Hibokhibok Volcano
Siaton Pt.
Bohol Sea
Butuan
Sulu Sea
Cagayan de Oro
Bugsuk I.
Balabac I.
Bancoran I.
San Miguel Is.
Balabac Strait
Iligan
Marawi
Mindanao
Zamboanga Peninsula
Illana Bay
Cotabato
Davao
Samal
Mt. Apo 2,954m
Banggi I.
Cagayan Sulu Is.
Zamboanga
Moro Gulf
Davao Gulf
Pilas Group
Basilan I.
Cape San Agustin
Turtle Is.
Pangutaran Group
MINDANAO AND SULU ARCHIPELAGO
General Santos
Jolo I.
Sandakan
Tapul Group
Sarangani Bay
Tinaca Pt.
Sarangani Is.
MALAYSIA
Tawitawi I.
Sulu Archipelago
Celebes Sea
Lahad Datu
Sibutu Group
Sibutu Passage
INDONESIA
Karakelong
120° East Longitude
0 100 200 300 400 500 600 700 800 900 Kilometres
0 100 200 300 400 500 Miles

## Map index

The capture of Corregidor on May 6, 1942 ended resistance in the Philippines. The islands were freed in 1945. The country's largest lake is Laguna de Bay, south of Manila. At Tagaytay, Lake Taal occupies a huge volcanic crater. In Lake Taal is another small, occasionally active, volcano which also has a small lake in its crater. The Pagsanjan River rapids, where tourists enjoy the rushing water, lie about 70 kilometres southeast of Manila.

In southeastern Luzon is the Bicol region, a long, narrow peninsula with a ragged coastline, which is often hit by typhoons. It contains hills, plains, hot springs, and a string of volcanoes, including Bulusan, Iriga, Isarog, and Mayon. Mount Mayon is an almost perfectly cone-shaped mountain, made up of alternating layers of lava and volcanic ash. Mount Mayon, which reaches 2,421 metres above sea level, is an active volcano, but most of its eruptions are mild. The most violent recent eruption occurred in 1814, killing about 1,200 people. Lava flows destroyed the town of Cagsawa, about 16 kilometres to the south. Near Mount Mayon is the hot springs resort of Tiwi. The mount Mayon area is now a national park and recreation area. The volcanic soils of Luzon are fertile and the island produces most of the country's rice and tobacco. It also has large deposits of copper, gold, and other minerals.

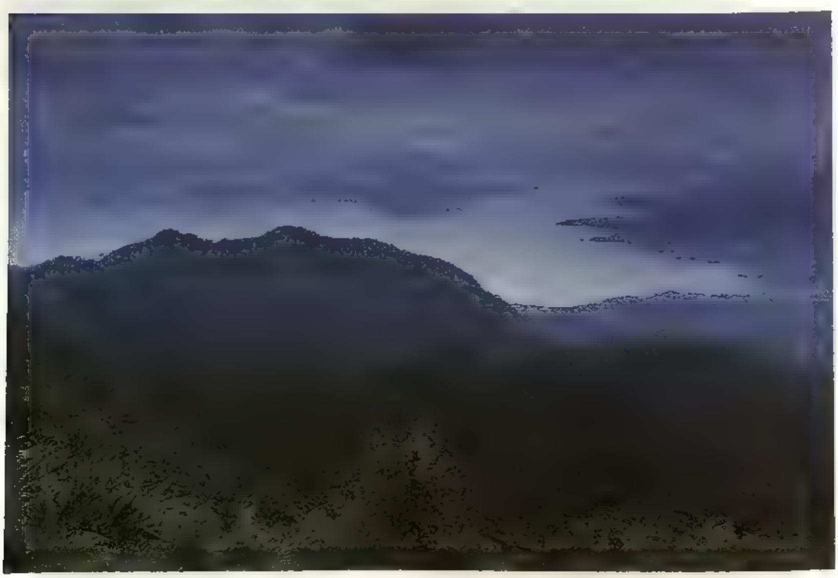
Mindanao (area 94,630 km²), is the second largest and most southerly of the major islands in the Philippines. It contains about a fifth of the country's population, including most of its Muslims. Mindanao has an irregular shape, with the finger-like Zamboanga peninsula in the west. It is largely mountainous and includes the country's highest peak, the dormant volcano Mount Apo. It is a four- or five-day climb to the top of Mount Apo. The Mount Apo region is a national park and a popular tourist attraction, because of its scenery, wildlife, and forests.

Northern Mindanao contains the fertile Agusan valley, while central Mindanao contains Lake Sultan Alonto. The Agus River flows out of Lake Sultan Alonto and then over a steep precipice, forming the scenic Maria Cristina Falls, before it drains into Iligan Bay. The Maria Cristina Dam is major source of hydroelectricity. Other dramatic waterfalls include the Catanico Falls near the northern port of Cagayan de Oro, an important centre of the pineapple industry.

**Manila hemp,** commonly called *abacá,* is grown in the Philippines. Its leaves contain a strong fibre used in making rope. This picture shows workers preparing the fibre for market.

Major tourist centres include the port of Zamboanga in the southwest, and Davao, on the southwestern Davao Gulf. The gulf is lined by good beaches which have a wealth of facilities for bathing and other water sports. Zamboanga's tourist attractions include an ancient Spanish fortress and Pasonanca Park. In the park, visitors can stay overnight in a tree house to enjoy the atmosphere.

Mindanao is one of the world's leading producers of *abacá* (Manila hemp). The leaves of the abacá plant contain a strong fibre, which the Filipinos use in making rope. The island also produces copra, maize, pineapples, and other crops. Mindanao contains important



**Lake Taal** occupies a huge volcanic crater in Batangas Province, about 100 kilometres south of Manila. In the centre is a small volcanic island formed by a later eruption, which also has a lake in its crater.

**Coconut palms** provide several important products. The nuts are used for food and drink, coconut oil, and *copra* (dried coconut). The fibre is used for making rope and matting. People make many useful objects from the shells and wood.

mineral deposits, including copper, iron, and nickel.

Samar (area 13,080 km²) is in the eastern Visayas. This hilly island is the third largest in the Philippines. It is linked to Leyte by the Marcos Bridge which extends across the San Juanico Strait. Samar has many fine beaches and thick forests cover large areas of this relatively undeveloped island. Many typhoons hit Samar. Farmers there grow abacá, coconuts, maize, and rice.

Negros (area 12,705 km²) is a boot-shaped island in the western Visayas. Volcanic mountains in central Negros separate the two sides of the island. Canlaon Volcano in northwest Negros is the highest mountain in the Visayas. It reaches 2,540 metres above sea level. The surrounding area is now a national park. The island is a major sugar producer, especially on the western plains around the city of Bacolod. Sugar is processed and exported from Bacolod. The farmers on Negros also raise tobacco in the fertile volcanic soils. Bananas and other tropical fruit are also grown.

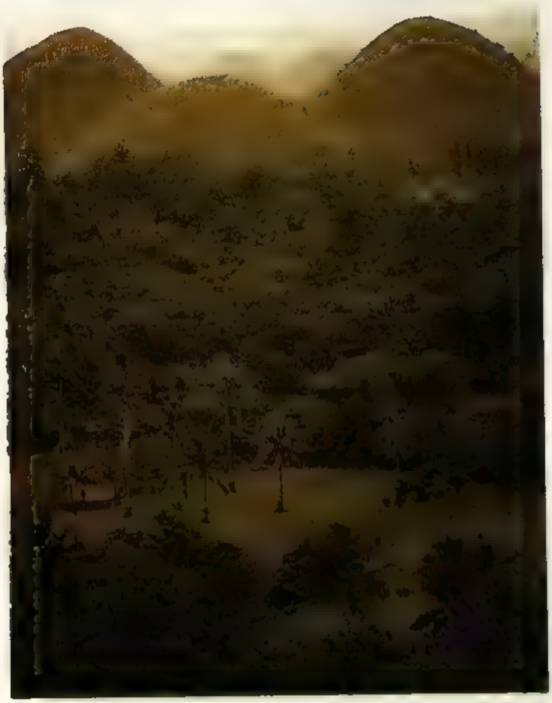
Palawan (area 11,785 km²) is a long, narrow island that lies west of the Visayas, between the Sulu Sea and the South China Sea. It is the most thinly populated of the major islands. Most of Palawan consists of forest-covered hills that extend almost the entire length of the island. The interior is sparsely populated and wildlife is abundant. Most of the people live on the narrow coastal plain, but farmers grow maize, rice, and vegetables on hillside farms.

Panay (area 11,515 km²) is the westernmost island in the Visayas. It has a roughly triangular shape and contains rugged mountains and rolling upland. The Iloilo Plain, in southeastern Panay, is one of the country's most fertile, densely populated areas. Farmers on Panay produce coconuts, rice, and sugar cane. The city of Iloilo is the trading and commercial centre of the western Visayas. A major tourist attraction in Iloilo is the *Roca Encantada* (Enchanted Rock), which is laid out as a mystic kingdom depicting the Garden of Eden.

Mindoro (area 9,735 km²) lies south of Luzon. The centre of the island is mountainous. Forests cover large areas, and the island has many unspoiled beaches. Mindoro produces coconuts, rice, sugar cane, and Philippine mahogany.

Leyte (area 7,214 km²) is in the eastern Visayas. This rugged, mountainous, and relatively undeveloped island became famous during World War II. It was the scene of the first landing of U.S. troops when they recaptured the Philippines from the Japanese in 1944, after the Battle of Leyte Gulf. A memorial statue marks the spot where the Americans landed, just south of the provincial capital, Tacloban. Leyte also contains the Mahagnao Volcano and the Lake Imelda national parks. The island is often hit by typhoons. Farms on Leyte produce abacá, coconuts, and rice.

Cebu (area 4,442 km²), in the central Visayas, is a long, narrow island, with a mountainous backbone running along almost its entire length. Cebu is the most densely populated island in the Philippines. The cutting down of trees has caused soil erosion. The island produces coconuts, maize, rice, sugar cane, and tobacco. It also has



**The Chocolate Hills** in western Bohol provide a spectacular landscape which attracts tourists.

some coal, copper, and gold. Cebu was the first island to be settled by the Spaniards. Its chief city, also called Cebu, was founded by Spanish missionaries in 1565 and was the capital of the Philippines until 1571. Today, it is a busy port. Many tourists in Cebu city visit the small, offshore Mactan Island where the explorer Ferdinand Magellan met his death in 1521. A monument has been erected to the Filipino, Lapulapu, who killed Magellan.

Bohol (area 3,865 km²), in the central Visayas, is a roughly circular island between Leyte and Cebu. A high plateau runs from the northeast to the southeast. In the west are about 1,000 small, cone-shaped hills. They are called the *Chocolate Hills* because of their conical shapes and because the vegetation covering them turns brown in summer. The hills were formed by the erosion of the coral and limestone bedrock of the region. They are popular tourist attractions. The people on this thickly populated island grow abacá, coconuts, maize, and rice. Fishing is a major industry.

Masbate (area 3,269 km²), is in the north-central Visayas, southwest of Luzon. This mainly hilly island is one of the chief gold-mining areas in the Philippines. Some copper is also found. Scattered farmlands on the islands produce coconuts, maize, rice, and sugar cane. Cattle-rearing is important.

The Sulu Archipelago, southwest of Mindanao, lies between the Sulu and Celebes seas. It consists of some mountainous islands formed from volcanoes and others formed from coral. They cover a combined area of about 980 km². Some historians believe that these islands, formed the route taken by Indonesian immigrants to the Philippines in ancient times. The islands of the Sulu Archipelago were once the home of pirates.

**Climate.** The Philippines lies in the tropics and has a hot, humid climate. During the hottest months, from March to May, temperatures may reach 38° C. Although the weather is cooler during the rainy season, which lasts from June to February, the temperature seldom falls below 21° C. The coolest months are November to February. Manila has an average temperature of 24° C in January and 28° C in May.

Rainfall in the Philippines averages 250 centimetres a year, with some areas receiving up to 460 centimetres. Manila has an average annual rainfall of 208 centimetres. The lowlands have less rain than the uplands because the mountains block winds that carry rain-bearing clouds from the Pacific Ocean.

Each year, between June and December, several destructive typhoons strike the Philippines, causing property damage and loss of life. The typhoons are especially severe along the eastern coast. The western coasts are protected from the effects of the typhoons by the mountain chains that run generally north-south throughout the islands. As a result, most of the country's ports and sheltered anchorages are on the western coasts or in deep harbours.

**Philippines precipitation**

## Economy

The Philippines is a developing country. In the late 1980's its per capita gross national product (GNP, the total value of goods and services produced in a year, divided by the population) was 630 U.S. dollars. In the 1980's, the economy grew at a slower rate than the population. As a result, the per capita gross national product declined.

The Philippine economy traditionally depended heavily on the production of crops and timber. But today, manufacturing makes a larger contribution to the gross domestic product (GDP, the total value of goods and services produced every year within the country).

The total work force numbers about 23 million people, with roughly 21 million in jobs. Of those in work, nearly half are engaged in agriculture. Another 40 per cent work in service industries, including the wholesale and retail trade, together with community, social, and personal services. Only about 10 per cent of the labour force work in manufacturing.

In recent years, many Filipinos, faced by rising unemployment in the Philippines and the demand for workers in some other Asian countries, have emigrated. By the late 1980's, the government estimated that the number of Filipinos working overseas totalled several million.

**Agriculture.** Most of the islands contain fertile areas, with rich soils formed from volcanic rocks. Because the Philippines is a developing country, agriculture still plays a major part in its economy. Agriculture accounts for about a quarter of the GDP. About half the land is used for growing crops and for grazing livestock, and nearly half the workers earn a living from farming. Almost all the cultivated land is owned by Filipinos, and the average size of farms is around 2 hectares.

The Philippines produces most of the food needed to feed its entire population. The main food crops are rice and maize. These two crops occupy more than half of the farmland. Other leading food crops include *cassava* (a starchy root) and sweet potatoes. Bananas, cacao, coconuts, coffee, mangoes, pineapples, sugar cane, and tobacco are grown for local use and for export. Farmers also grow *abacá* (Manila hemp) and rear *carabaos* (water buffaloes), cattle, pigs, goats, and poultry.

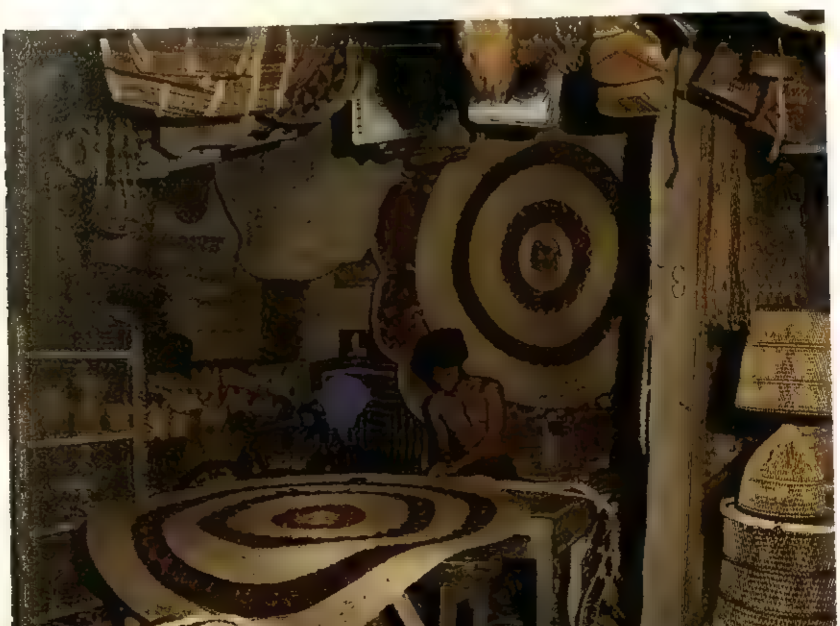
Many of the farmers rent their land and pay the owner a share of the crop. Most farms in the islands lie on the lowlands, but farmers also grow crops on terraces on hillsides and mountain slopes.

**Forestry.** Forests cover about half of the land in the Philippines. More than 3,000 kinds of trees grow in the islands. About 90 per cent of the country's timber comes from several related *dipterocarp* trees, called Philippine mahoganies. Mangroves and pines also yield a small proportion of the country's timber.

The kapok tree produces a fibre, also called *kapok,* that is used in making insulation, mattresses, and upholstery. Bamboo grows throughout the islands. The people of the Philippines use the stiff, hollow stems of this plant in building houses and in making baskets, furniture, and other items.

**Mining.** The Philippines is rich in mineral resources and minerals are important exports. The estimated reserves of copper and nickel are among the richest in the world, though the reserves of iron and gold have declined in recent years.

Copper is found mostly on Luzon, Cebu, Negros, and Samar. Large gold mines operate in northern Luzon. Some platinum and palladium is also mined in the Philippines. The country has rich deposits of chromite, coal, cobalt, iron ore, lead, manganese, nickel, silver, and zinc. Nonmetallic materials include gravel, limestone, marble, salt, and silica sand.



**Mats and baskets** made from traditional materials are used in domestic life throughout the Philippines. This workshop in Legazpi makes them from locally produced fibres by plaiting, coiling, sewing, and weaving.

**Fishermen** shake out the last of their catch on a beach on Mindoro. Coastal fishing provides food that is consumed locally and sold for commerce. Fish such as anchovies and sardines are commercially important.

**Fishing industry.** The Philippines is a huge *archipelago* (a broad expanse of sea containing many islands). The waters surrounding the islands contain anchovies, mackerel, sardines, scad, tuna, and other fish. Crabs and shrimp also live in the island waters. The major coastal fishing grounds are around Mindoro, the Sulu Archipelago, and Zamboanga on Mindanao. Deep-sea fishing is carried on in Manila Bay and also in the Palawan and Sulu seas.

Near the southern islands, divers gather sponges and certain shellfish, including clams and oysters, from which mother-of-pearl is obtained. Fish farming is also important. Milkfish, shrimp, and tilapia are raised in ponds along the ocean shores and near river mouths.

**Manufacturing.** Manufacturing accounts for a third of the GDP, though it employs only a tenth of the work force. The manufacturing of food and beverages is the largest single industry in the manufacturing sector. More than 1,000 of the 5,000 large manufacturing plants produce food. Other major industries of the Philippines produce cement, chemicals, cigars, clothing, electrical machinery, refined metals and petroleum products, sugar, textiles, and wood products.

Many companies operate factories in the Philippine *export-processing zones,* where businesses can import foreign goods without paying import taxes. These factories produce such items as clothing, electronic equipment, furniture, and shoes. The government also gives

**Gold ore** is one of the minerals mined in the Philippines, especially in northern Luzon. The islands also have rich deposits of many other metallic ores, including cobalt, copper, iron, lead, nickel, silver, and zinc.

incentives to investors in certain industries, especially those that are export-oriented. More than half of the investment has come from Filipinos, and the rest from foreigners, especially the Japanese and Taiwanese.

**Electric power.** The Philippines uses several forms of energy. The Philippines has to import oil to fuel power stations, but it has considerable hydroelectric power, with major dam projects on Luzon and Mindanao. Of the total installed capacity, hydroelectric power stations account for nearly 40 per cent, oil-fuelled plants more than 40 per cent, and coal, thermal, and other plants for the rest.

**Services.** Service industries include education, finance, government services, housing, medicine, property, trade, and transportation. Together, service industries account for about 40 per cent of the GDP, and they employ about 40 per cent of the work force.

**Foreign trade.** The Philippines cannot produce everything it needs, and so it depends heavily on foreign trade. The value of the nation's annual trade represents about 50 per cent of the annual GDP.

The chief exports used to be abacá, bananas, coconut oil, copper, copra, dessicated coconut, gold, logs and timber, canned pineapple, and sugar. Until 1978, these ten products were more than half of the exports. By 1988 they were only a fifth of the total exports.

The decline of the traditional exports is explained by the rise of manufactured exports, which were 65 per cent of the value of the exports in 1988. Especially important exports are clothing, electrical and electronic equipment and parts, and telecommunications. Other important exports are chemicals and furniture.

The leading imports include machinery and equipment, raw materials, including petroleum and chemicals, and semiprocessed materials. The value of the imports normally exceeds the value of the exports.

The U.S.A. has been the Philippines' main trading partner for the last 50 years. The U.S.A. takes about a third of

**Philippines**
Economy

the Philippine exports and supplies about a fifth of the imports. Japan is the country's second most important trading partner. Other leading partners include Australia and the European Community.

**Tourism.** About one million tourists are attracted to the Philippines every year. Visitors enjoy the warm climate, superb volcanic scenery, unspoiled coral and sandy beaches, magnificent birdlife, and beautiful forests, lakes, and rivers.

**Transportation.** The country has an extensive road network, totalling more than 157,000 kilometres with about 11,300 bridges. However, only about 15 per cent of the roads are paved. Registered motor vehicles total about 1,270,000. In most cities, brightly painted and decorated vehicles called *jeepneys* serve as shared taxis. They pick up as many passengers as can be crammed in. Buses and jeepneys provide most local transportation in the islands.

Rail, air, and water transport facilitate domestic trade between the regions of the country. The nation's railways operate mainly on Luzon, and the Manila area has an elevated light-rail rapid transit system. The government plans to extend the rail lines to ease the traffic jams that overburden the current road and rail systems.

The main international airports are the Ninoy International Airport in Manila, and the Mactan International Airport in Cebu. The country has more than 390 operational ports. The leading ports are Manila, Cebu, Iloilo, and Zamboanga.

**Communication.** The Philippines has about 20 daily newspapers, which represent a variety of political opinions. Most are published in English and some are printed in Filipino, Chinese, or other languages. Among the largest newspapers are *The Manila Bulletin*, and *The Philippine Inquirer*, both printed in Manila.

**Brightly decorated taxis** called *jeepneys* furnish inexpensive transport in cities throughout the Philippines. These vehicles were originally made from World War II jeeps.

**Manufacturing businesses** in the Philippines now earn as much as farming, and government banks help them to develop. This one produces bodywork for vans and taxis called *jeepneys* that are used for transport in the islands.

The Philippines has an average of about 1 television set for every 9 people. Several television networks operate stations throughout the islands. A large number of radio stations broadcast in the Philippines. There is about 1 radio to every 8 people. The Philippines also has one telephone to every 65 people.

**Economic problems.** Despite the considerable economic progress in the last 30 years, many Filipinos are poor and their diet falls below the recommended nutritional level. Such people are vulnerable to illness. The government estimates that half of the families live at, or below, the poverty level. The poorest areas are Northeastern Luzon (the Cagayan Valley) and Eastern Visayas (Samar-Leyte).

One problem that the Philippines shares with many other developing countries is that it has a young and rapidly increasing population. The population is increasing at more than 2 per cent per year, which is considerably above the world average rate. Nearly 40 per cent of the population is under 15 years of age, while only 14 per cent is 45 or older. Countries with young populations have high expenditure on education and health. Another effect of a young population is that the country's work force increases rapidly.

Other problems arise from the unequal distribution of income, which has not changed significantly over a long period. The government has tried to introduce reforms to reduce poverty, including giving direct assistance to the poor and investing money in job creation, but the changes are slow. The top 10 per cent of families account for about 40 per cent of the total income. The bottom 10 per cent of families control 2 per cent of income.

In the late 1980's, the Philippines had an unemployment rate of nearly 10 per cent. But nearly 30 per cent of the work force was underemployed. As a result, the incomes of such people are low, although they are classified as being in work. The causes of unemployment

and underemployment include the rapid growth of the population, lack of skills, and the emphasis on capital-intensive rather than labour-intensive industries.

Agricultural problems, including insufficient credit, poor transportation, and inadequate processing and marketing facilities, were caused by the emphasis on developing industry to reduce the imports of manufactured products. In the 1980's, the government attempted to raise incomes in rural areas, improve farmers' living conditions, and increase agricultural productivity. The government faces difficulties in financing agricultural reforms, because it also has to encourage its fast-growing export industries.

The Philippines needs money to make agriculture more efficient and to continue the development of its manufacturing industries. Overseas borrowing is important in funding these reforms, but the *servicing* (paying the interest) of the country's debts may make economic development difficult.

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**Physical features**

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Bataan Peninsula
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Philippines, History of the

**Outline**

**I. People**
- A. Population and ancestry
- B. Languages
- C. Rural life
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**II. Land and climate**
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- F. Electric power
- G. Services
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- I. Tourism
- J. Transportation
- K. Communication
- L. Economic problems

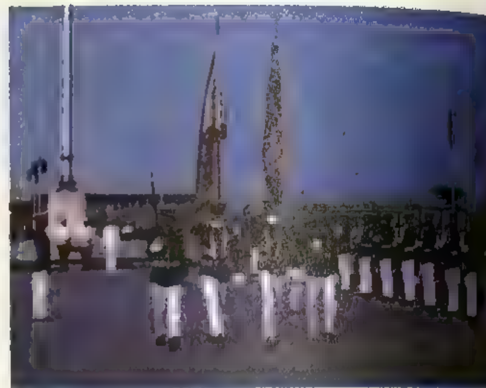
**Questions**

What is the chief religion in the Philippines?
What is a *barrio?*
What is a *balintawak?*
What is the largest and most important island of the Philippines?
What caused the wide variety of cultural differences among the Philippine people?
Who owns most of the farmland in the Philippines?
What are the nation's two main food crops?
What is a *jeepney?*

**Cargo and passenger ships** use the docks of Manila, the Philippines' busiest port, *above*. The nation depends heavily on ships for local transportation and international trade.

**Philippines, Armed services of the.** The armed services of the Philippines includes an army of about 68,000 men and women, supported by 100,000 reserves. There is a navy of 25,000, including 8,000 marines and 2,000 coastguards. The air force has about 15,000 members. There are also about 50,000 police, a large proportion of which form a *paramilitary organization* (an organization set up on military lines).

The forces protect their nation from any outside enemy. But for many years, they have also been involved in internal conflicts. Many of the larger inhabited islands of the Philippines are mountainous, making them difficult to patrol. The main work of the armed services has been in counter terrorist measures against the Communist-inspired New People's Army (NPA). Most of the Philippines population is Malay and Roman Catholic. But about 3 million Muslims live in the south of the country. The NPA draws most of its support from these Muslims.



**The armed services** have internal security as their main task but they also perform some ceremonial duties.

### Defence and organization

The president of the Philippines is the commander in chief of the armed forces. These forces are made up of the army, navy, air force, and Philippines constabulary, a national police force. The government department that organizes the armed services is the Department of Defense.

**The army** has branches of infantry, armour, artillery, engineers, signals, and *logistics* (movement and maintenance of the forces). The eight infantry divisions, a single light armoured brigade, three engineer brigades, eight artillery battalions, a special service brigade, and a presidential security group are spread among six area commands. The armoured brigade is equipped with lightly armed British Scorpion tanks.

**The navy** operates from six naval districts and two bases at Sangley Point and Zamboanga. It is basically a home defence force. It has two former U.S. frigates of the *Datu Siratuna* class which can be used for deep-water antisubmarine duties. The remaining patrol boats, coastal vessels, and inshore craft undertake coastal surveillance to prevent arms being smuggled to rebels.

**The air force** is quite small. It is made up of about 100 combat aircraft, including 70 armed helicopters, and has 7 squadrons of transport aircraft. The air force is also employed almost exclusively in a campaign against various rebel movements. The Aviation Security Commando (AVESCOM) was formed in 1972 from the best parts of the air force. It provides the Philippines with its principal unit for rescuing hostages.

**The integrated national police force** also forms part of the armed services and is divided into 14 regional commands. The integrated police force carries out general police duties. The Philippine National Police (PNP) has headquarters at Camp Crame, Quezon. There are about 50,000 men in the constabulary. It has its own support units, including light transport aircraft. The constabulary's Manila-based Metropolitan Command looks after internal security. It has wide-ranging powers.

**Recruitment and training.** Until 1972, when civil war broke out in the south of the country, the Philippines armed services were recruited by conscription on a selective basis. After 1972, recruits were conscripted on a much wider basis. As a result, the army expanded rapidly from 16,000 men and women in 1972 to 50,000 in 1976. Since then, the army has increased steadily to its present size.

Officers train at the Philippines Military Academy at Baguio in northern Luzon. Other ranks receive their training within their own units.

### History

Filipinos do not have a strong collective military tradition. In earlier times, the Spaniards and the Americans ruled the Philippines. Neither allowed the Filipino troops much control or responsibility.

In 1935, the United States conferred Commonwealth status on the Philippines. In an attempt to deter foreign aggression, it allowed Filipinos to set up their own armed forces. As a result, the Philippines government conscripted and trained up to 40,000 troops a year. These troops worked in close cooperation with the regular American garrison, which remained at full strength. But during World War II (1939-1945), this combined force was not equipped to face the full might of the invading Japanese army. After a heroic defence, the combined force surrendered in February 1942. After the war, the United States granted independence to the Philippines, entrusting power to their prewar political allies.

The Philippines army was small at first. In 1950, it was expanded to destroy the Communist People's Liberation Army. It was then promoted from a counter-insurgency unit to a conventional defensive formation. In 1957, it became part of the South East Asia Treaty organization (SEATO), and internal security reverted to the Philippines constabulary.

In 1972, a rebellion broke out among Muslims who wanted a separate state in the south. Also, rebels in the New People's Army fought in many areas, including Manila, seeking a Communist takeover of the country. President Marcos used the national emergency to introduce martial law throughout the nation. He expanded the army to its present size, and used it to strengthen internal security. After the fall of Marcos and the return of democracy in 1986, internal security continued to be the main role of the armed services until 1991. Then, the Philippine National Police was formed, with responsibility for internal security.

See also **Philippines; Philippines, History of the.**

***Laundrywoman*** was painted in 1942 by Fernando Amorsolo. Amorsolo was a gifted painter and graphic artist. He specialized in portraits and landscapes, and in *genre* scenes, taken from ordinary, everyday life.

**Philippines, Art of the.** The art of the Philippines reflects the varied traditions of its people. Ancient Filipino painting, pottery, carving, weaving, metalwork, and jewellery show links with Southeast Asia, India, and China. In the past 500 years, Philippine folk art, carving, weaving, and jewellery have been influenced by Spanish and other European cultures. Contemporary paintings and sculptures have also been influenced by mainstream trends in Europe and America.

Different types of art in the Philippines have influenced each other. For example, many Filipino painters of the 1900's work within formal contemporary European and American styles. Yet at the same time they borrow from folk art tradition. On the other hand, some Filipino artists working within the folk art tradition take up ideas from modern art. The Filipino *avant-garde* movement, which practises modern trends in art, is characterized by a concern for local Philippine art and ritual rather than for foreign traditions.

This interchange reflects the nature of the Philippines as a nation. It is a country where many peoples with different cultural traditions live side by side. Scholars have identified at least 258 *ethnolinguistic* groups (people with different languages and cultures). Among these groups are small, nomadic societies, small, preindustrial farming societies, and highly industrialized, urban societies.

The majority of Filipinos are Christian. There is also a sizeable and culturally unified Muslim community. There are also some small villages of people who still practise traditional *animism* (see **Animism**). Each of these groups maintains strong cultural individuality, adding to the diverse nature of Philippine art.

## Philippine prehistoric art

**The earliest remains** of humans living in the area that comprises the Philippine *archipelago* (island group)

***Nuestra Señora del Rosario*** *(Our Lady of the Rosary)* is a Madonna and Child icon in the Spanish Baroque tradition.

Earthenware, 66 cm high. National Museum of the Philippines, Manila

***The Manunggul jar,*** found in Manunggul cave on Palawan Island, dates from Neolithic times.

date from about 750,000 years ago. Prehistoric art was closely interwoven with religious, economic, and social life. The societies responsible for this early art have disappeared. What remains of their stone carving, pottery, and jewellery, is admired for its beauty. But the reasons for its creation are not fully understood.

**Pottery** was first made in the Philippines about 6000 B.C. Archaeologists continue to explore new sites. But most believe that by 4000 B.C. pottery making was well established in the Philippines. Red pottery made by *slip casting* (a technique of mould shaping), was found in the Laurente Caves in the Cagayan province of northeastern Luzon. They were made around 5500 B.C. Pottery found on Sanga-Sanga island in the Sulu archipelago dates from between 6000 and 4000 B.C. Pottery fired at a low temperature and dating from about 3600 B.C. was discovered at a site in Masbate Island. The first example of decorated Filipino pottery was found at the same site. The pottery has engraved parallel and combed lines, and dates from about 1600 B.C. Later pottery includes globe-shaped pots and shallow dishes made from coiled pieces of clay. Examples of this pottery have been found in Isabela province in northeastern Luzon.

**The Manunggul jar** is the most valued prehistoric artifact that has been discovered in the Philippines. It is a burial vessel with a lid and was found on Palawan Island in the Tabon cave complex. As well as the jar, a number of engraved, polished, and impressed vessels were also found. The cave also contained the oldest known example of painted pottery in the archipelago.

The Manunggul jar is the work of highly skilled artists. On the shoulders are curved, incised scroll lines, painted with red *haematite* (iron oxide). On the lid is a boat, with a boatman and passenger.

### Philippine traditional art

Although the Philippines is made up of many ethnic groups, there are shared cultural elements among its people. From the 1500's to the early 1800's, the Philippines was a Spanish colony. It then became an American colony in 1898. The colonists tended to isolate inland and highland people from the coastal and lowland people. The latter were more influenced by European and American cultures.

The traditional art of those Philippine societies that escaped colonization are now described as *ethnographic.* Fine art museums are increasingly collecting ethnographic sculpture, jewellery, and textiles.

The Gran Cordillera Central, a mountainous region of northern Luzon, is the homeland of a number of varied ethnic groups. Mindanao and nearby islands developed many ethnographic traditions, including Muslim ones.

**Sculpture.** The Kankana-ey and Ifugao ethnic groups from northern Luzon possess a distinct sculptural tradition. The *bulol* tradition usually features a pair of figures carved in dark wood. The figures have highly stylized features. They have religious significance and are associated with the protection of rice harvests. The *hagabi* is a large bench with sculpted pig-like heads at each end. It is a sign of social status.

**Weaving.** The Itnegs, another ethnic group from northern Luzon, are well known for their intricate weaving. The *binakol* is a blanket which features an optical illusion design (see **Optical illusion**). Weaving of the Ga'dang people usually has bright red tones. Their weaving is identified by rich, beaded ornamentation. The Ilongot made extremely fine jewellery from mother-of-pearl, red hornbill beak, plants, and metals. Until recent times, ownership of such jewellery was associated with head-hunting prowess.

**Ikat dyeing.** On the island of Mindanao the Bagobo, B'laan, Mandaya, Mansaka, and T'boli peoples became skilled in the art of dyeing *abaca* fibre. Abaca is a Philippine plant related to the banana family. Its leaf stalks are

Early 1900's. Cultural Center of the Philippines, Manila

**A *hagabi*** is a large, carved wooden bench that is a traditional sculptural form in northern Luzon.

Ayala Museum, Manila

*Crucifixion* is a Roman Catholic devotional icon finely carved and decorated in a traditional Spanish style.

1876. Oil on canvas. 111 by 83 cm. Lopez Memorial Museum, Manila

*El Violinista (The Violinist)*, by Juan Luna. Luna was one of the first Filipino artists to achieve recognition in Europe.

used to make a fibre known as *Manila hemp.* The fibre is dyed by a method of *tie dyeing* called *ikat* in the Philippines (see **Tie dyeing**). Ikat textiles are woven into intricate geometric patterns with human, animal, and sometimes plant *motifs* (pictorial themes).

**Muslim art.** Most Philippine Muslims live in Mindanao and the adjacent Sulu archipelago. They have two main artistic styles. One is a curved-line woodcarving and metalworking style called *okir,* similar to Middle Eastern Islamic art. This style is associated with men. The other style is geometric tapestries, and is associated with women. Tausugs and Sama-Bajaus exhibit their okir on elaborate gravemarkers with boat-like imagery. The Marananaos make similar carvings on ancestral houses called *torogan.* Weapons made by Mindanao's Muslims are skilfully carved, with curving lines.

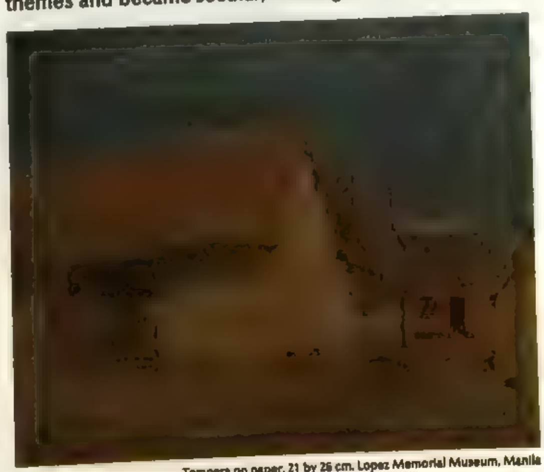
## Folk art

Folk art, as currently studied by Philippine scholars, consists of art that flourished as a result of Spanish and American influence.

Spanish influence can be seen mainly in religious relief work, sculpture, and painting. *Santos* are carved images of Christian saints with Asian, European, or *indio* (local) features. Carved in wood or ivory, or sometimes modelled in clay, they were usually elaborately decorated and gilded. They became a feature of many homes and churches. *Bas-relief* was used for altar fronts and other church furniture such as pulpits (see **Relief**). Shrines called *urnas,* and candle-holders, tended to be richly decorated with scrolls, flowers, leaves, and other motifs. Part indigenous, part European, the style is sometimes called *folk Baroque* (see **Baroque**). After being colonized, the indio people had their first experience of two-dimensional, representational art. This was painted religious imagery from Biblical sources, as well as engravings and lithographs featuring Christian *icons.*

## Philippine modern art

Philippine art slowly moved away from religious themes and became *secular,* dealing with subjects other



Tempera on paper. 21 by 26 cm. Lopez Memorial Museum, Manila

*Casas de Campo (Country Cottages)*, by Felix Hidalgo. Hidalgo, like Luna, had worked and studied in Europe.

1928. Oil on wood. 318 × 121 cm. Cultural Center of the Philippines, Manila

***The Builders*** is by Victorio Edades. Edades, who trained in America, brought to the Philippines the influences of American Expressionism and European post-impressionism.

than religious ones. This came about at the same time as the rise of a wealthy, educated, *mestizo* (of mixed Spanish and Filipino ancestry) class that eventually mounted the revolution against Spain in 1896.

The painter Damián Domingo is associated with the trend from religious to secular painting. Working in the mid-1800's, he produced portraits and studies of Filipino people. Juan Luna and Felix Resurrección Hidalgo were Filipino painters who spent much of their lives outside the Philippines. They won awards at the National Exposition of Fine Arts in Madrid, Spain, in 1884. Their work showed a trend for Philippine painting to be an instrument for political statement. Their works influenced many Filipino artists of the 1900's.

For a time, a distinct style characterized Philippine painting. From 1898 onward, painters of the early American period promoted a genre of painting that invested Philippine landscapes with qualities of sweetness and light. Examples are the work of Fernando Amorsolo, Fabián de la Rosa, and Jorge Pineda. Amorsolo used remarkable technical skills to produce paintings which romanticized Filipino culture and nature.

In the late 1920's American-trained painter Victorio Edades challenged this aesthetic position. His works were immersed in modernism (see **Modernism**). He was followed by an early *avant-garde* group of artists influenced by either American Expressionist or European post-impressionist ideas (see **Expressionism** and **Impressionism**). This group included Carlos Francisco, Hernando Ocampo, Vicente Manansala, Cesar Legaspi, Anita Magsaysay-Ho, Romeo Tabuena, Fernando Zobel, and Arturo Luz. They sought to rework modernism in terms that reflected Philippine realities.

**Modern Filipino artists** brought about several developments. Painting of the sentimental Amorsolo school became devalued and was regarded as folk art. A split developed between those artists who embraced international mainstream art, and those who turned to art that exclusively mirrored life in the Philippines. The internationalists include David Cortez Medalla, an expatriate sculptor in the United Kingdom, who became an important figure in kinetic performance and environmental art; Roberto Chabet, whose work is the intellectual and spiritual centre for young modernists and post-modernists; Napoleon Abueva, whose sculpture is modernist as well as *avant-garde;* and Lee Aguinaldo, whose work is notable for its strict adherence to international mainstream measures of competence.

***Doña Aurora Quezon*** is by Fabián de la Rosa, who specialized in landscapes, genre scenes, and portraits.

See also **Amorsolo, Fernando; Hidalgo, Felix; Luna, Juan.**

**Voting in the Philippines** is by secret ballot, so that no one can discover how a person has voted. The people elect the president, vice president, senators, and representatives by direct vote.

**Philippines, Government of the.** The Philippines Constitution specifies that the country is a democratic and republican state and that civilian authority is, at all times, supreme over the military forces. The head of state is the president. The Constitution was adopted in 1987.

### The system of government

**The president** holds the executive power. He or she must be a native citizen; a registered voter; able to read and write; at least 40 years of age; and a resident for at least 10 years immediately before the presidential election. The vice president must have the same qualifications.

The people elect both the president and the vice president by a direct vote for a term of six years. The president may not stand for a second term. No vice president may serve for more than two successive terms.

The president is the commander in chief of the armed forces, and may call on them to prevent or suppress lawless violence, invasion, or rebellion. In cases of invasion or rebellion, the president may suspend the privilege of *habeas corpus* (a measure which restricts detention without trial) or place the country under *martial law* (military rule) for a limited period. There are constitutional restrictions to this emergency power. The Supreme Court reviews the necessity of the presidential measures and Congress may revoke them. A state of martial law does not affect the operation of the Constitution or the civil courts.

**Congress** holds lawmaking powers. It has two houses, the Senate and the House of Representatives. The Senate has 24 senators, elected by the people for a term of six years. Candidates for the Senate must be Philippine-born or naturalized citizens; at least 35 years of age; able to read and write; registered voters; and residents of the Philippines for not less than two years immediately preceding the election. No senator may serve more than two consecutive terms.

The House of Representatives has 250 members, of whom 200 are elected from legislative districts. Candidates for election to the House need qualifications similar to those required of candidates for the Senate. In addition, 8 representatives are appointed by the president. Representatives serve a term of three years, and none may serve more than three consecutive terms.

The people also elect 50 representatives to seats reserved for party list representatives. These 50 seats are divided according to the proportion of votes received by the leading parties in the election. The aim of the party list system is to encourage people to vote for issues and political parties rather than for personalities.

**Lawmaking.** Congress makes the laws of the Philippines. Every bill passed by Congress covers only one subject, which is expressed in its title. Before it becomes law, a bill must pass through three readings on separate days. The members of Congress receive printed copies of the bill three days before its passage. After the last reading, members immediately take a vote on the bill.

Congress then presents the bill to the president for approval and signature. If the president *vetoes* (rejects)

**How a bill becomes law in the Philippines**

The Congress of the Philippines is responsible for introducing and passing legislation. Either the House of Representatives or the Senate may introduce a *bill* (planned legislation). But a bill must be approved by both of these chambers, and approved by the president, to become law.

**First reading.** When a bill is introduced in one of the two houses, only its title is actually read. After the bill is approved at this stage, its text is printed and distributed.

**At the second reading,** the legislators debate the bill. If it is approved at this stage, it is returned for amendments by the committee where it originated.

**Committee Amendments.** The committee will draw up the amendments based on points raised in debate. Then the committee will debate the amended sections. Individual amendments approved on the floor will be incorporated.

**Third reading.** A debate takes place and the final amendments are put to a vote. If the bill is approved on the third reading, it is passed on to the other chamber.

**Other chamber.** The bill referred to the other chamber goes through the same process. If the second chamber amends the bill, it must be returned to the chamber of origin for its approval.

**Presentation to president.** When the bill is passed by both chambers, it is sent to the president for consideration. If the president approves the bill, it becomes law. If the president vetoes the bill, it returns to the chamber of origin with the president's written objections.

**Overruling a veto.** If, after reconsideration, two-thirds of all the members of the chamber of origin agree to pass the bill, it will be sent to the other chamber. If approved by two-thirds of that other chamber, the bill in question becomes law.

**The Supreme Court,** housed in this building in Manila, has power to review and restrain official decisions. It supervises the administration of justice and is the final arbiter of legal dispute.

the bill within 30 days, it returns to Congress. The president can veto any particular item in a bill which involves the raising of taxes, revenues or tariffs.

**The law courts.** The Supreme Court and the lower courts are in charge of the judicial process. A chief justice and 14 associate justices sit in the Supreme Court. The members of the Supreme Court and judges of the lower court hold office until they reach the age of 70 or become too ill to discharge their official duties.

The president appoints a judicial and bar council, supervised by the Supreme Court. The council recommends new members to the judiciary. Council members serve a term of four years.

**Local government.** The territorial and political subdivisions of the Philippines are the provinces, cities, municipalities, and *barangays* (villages). These local areas are guaranteed local autonomy under the Constitution.

The president has general power over local governments. Local officials serve a term of three years. The barangay officials are elected for a term of six years. None of the local officials may serve more than three consecutive terms.

**Political parties.** The political system of the Philippines has developed on American lines with a president and congress. This system contrasts with former British colonies, many of which have parliamentary systems and strong and independent civil services.

The system also reflects the economy, which is mainly agricultural. In rural areas, tenants depend largely upon their landlords. A landlord provides favours to the tenants, and in return the tenants give services and loyalty. There is also an element of kinship. The paternalistic landlord acts as the head of a large family and the tenants consider each other as relatives. Religious ceremonies such as baptisms and weddings are opportunities for strengthening these bonds, with the landlord usually becoming the *padrino* (godfather) in such rites.

In the early 1990's, the party called Laban ng Demokratikong Pilipino identified closely with President

**Presidents of the Philippines**

| Name | Dates served |
|---|---|
| **Emilio Aguinaldo** | President of the First Philippine Republic (1898-1901) |
| **Manuel Quezon** | President of the Commonwealth of the Philippines (1935 until his death in 1944 while in exile in U.S.A.) |
| **José Laurel** | President, Second Philippine Republic (1943-1944 during the Japanese occupation) |
| **Sergio Osmeña** | As vice president, succeeded President Manuel Quezon (1944-1946) |
| **Manuel Roxas y Acuña** | Last president of the Commonwealth and first president of the Third Republic (1946-1948) |
| **Elpidio Quirino** | 1948-1954 |
| **Ramón Magsaysay** | 1954-1957 |
| **Carlos García** | 1957-1961 |
| **Diosdado Macapagal** | 1961-1965 |
| **Ferdinand Marcos** | 1965-1986 |
| **Corazon Aquino** | 1986-1992 |
| **Fidel Ramos** | 1992- |

Corazon Aquino. The Liberal Party also cooperated partially with the Aquino administration. The Nacionalista Party was the main opposition.

President Ramos, who was elected in 1992, had the support of a coalition between Lakas ng Edsa and the National Union of Christian Democrats (NUCD). The Nationalist Party and the Liberal Party agreed to cooperate. These traditional parties draw their strength from prominent political figures and their ward leaders.

Social democratic parties, such as the NUCD and the Pilipino Democratic Party, have a large membership and widespread organization. These parties also have links with nongovernmental organizations which share their ideologies.

### Philippine constitutions

**Malolos Constitution of 1899.** The Revolutionary Government proclaimed Philippine independence from Spain on June 12, 1898. The government drew up a constitution in 1899 in Malolos, Bulacan. It was the first democratic constitution in Asia, and stated that sovereignty belonged exclusively to the people. The constitution separated church and state and guaranteed the law and civil rights.

The 1899 Constitution also created an Assembly of Representatives which would pass laws. The president had executive power and was elected by the majority of the Assembly for a term of four years. To ensure that the president did not abuse his powers, the secretaries of the government were made responsible to the Assembly.

**The 1935 Constitution.** The government framed a new constitution on Feb. 8, 1935. It was amended in 1940.

Under the 1935 Constitution, the president's term of office changed from six years without reelection to four years with one reelection. The legislative body became a *bicameral* (two-chamber) system. Members of the Senate were elected nationwide. An independent constitutional body enforced election laws.

This Constitution confirmed basic democratic principles, including sovereignty of the people, separation of powers, strong executive power, and independence of the judiciary. It also adopted a bill of rights and a presidential form of government. The executive had more powers than those enjoyed by the executive under the U.S. Constitution.

**The 1943 Constitution.** In June 1943, the Japanese colonizers ordered the Filipino officials of the Executive Commission to prepare a new fundamental law. After three months, the members of the Preparatory Commission for Philippine Independence finished a draft document. Three days later, it was *ratified* (officially approved) by the Kalibapi, the pro-Japanese national movement.

Members of the National Assembly elected a president for a term of six years. A Council of State advised the president on matters of national policy. The single-

**Batasang Pambansa** is the Filipino title of the national assembly, or parliament, of the Philippines established by the 1973 Constitution. It meets in the imposing building shown below.

chamber Assembly was made up of delegates from each province and city, as well as the provincial governors and city mayors.

The Supreme Court and the other courts formed the judiciary. The president appointed the chief justice and the associate justices as well as the judges of the lower courts.

The Bill of Rights stressed the duties and obligations of the citizens rather than their rights and freedoms. To win the sympathies of the people, Tagalog became the national language.

**The 1973 Constitution.** When the Philippines regained independence in 1946, the 1935 Constitution was once more put into effect. The Parity Amendment of 1947 allowed American citizens to exploit natural resources and to own public utilities. In the late 1960's, popular demand grew for a new constitution. The government set up a convention to reform the constitution in June 1971, but before it could finish its work President Ferdinand Marcos imposed martial law. His second term as president was due to expire in 1973, and the 1935 Constitution did not allow him to stand for office again. In January 1973, he proclaimed a new constitution.

The 1973 Constitution established a parliamentary form of government. The prime minister, who was to be elected by members of the *Batasang Pambansa* (National Assembly) from among themselves, could be removed by a vote of no confidence. The president was to become a ceremonial head of state. But these parliamentary processes never came into effect.

President Marcos actually wielded supreme power. In 1981, this power became law when a constitutional amendment made the president both head of state and chief executive. He was to be directly elected by the people for a term of six years. The president would also nominate the prime minister, who would be the head of the Cabinet.

Although martial law ended in January 1981, President Marcos continued to exercise authoritarian power. In the presidential election held in June 1981, he was once more reelected.

**The 1987 Constitution.** After the overthrow of the Marcos regime in 1986, President Corazon Aquino formed a commission to frame a new constitution. The body finished the draft charter in four months. An overwhelming majority of voters showed their approval in a referendum in February 1987.

The Constitution adopted the presidential form of government and guaranteed more civil rights than before. It gave particular attention to social justice, by recognizing the economic and social rights of workers, the peasantry, women, children, and local communities. The state gave priority to land reform, education, and social services. The new charter also upheld nationalism and banned nuclear weapons on Philippine territory. It decreed the termination of the agreement on US military bases by 1991. A new treaty was allowed only under stringent conditions.

## Political history

**The barangay.** During the precolonial era before the arrival of the Spanish in the 1500's, the basic political unit was the *barangay* (small, independent villages), governed by a *datu* (local headman) or *rajah*. The ruler had executive, lawmaking and judicial powers. The elders gave the ruler advice on public affairs. Although many barangay had written laws, most made use of customs.

The barangay were independent units, but some joined together in confederations. There were three social classes: nobility, freemen, and serfs and household servants. There was no slavery in the Philippines.

**The Muslim sultanates.** The arrival of Islam in the 1300's encouraged the forming of more advanced political communities. The Arab scholar Mudum introduced the new religion when he came to Sulu from the Malay Peninsula in about 1380. In 1390, Rajah Baginda of Minangkabau, Sumatra, arrived in Sulu and converted more local people to Islam. Sarif Abu Bakr left Johor for Sulu in 1450, and married Baginda's daughter. He later became the sultan of Sulu.

In other parts of Mindanao, Serif Kabungsuan of Johor laid the foundations of the Muslim faith. When he became the first sultan of Mindanao, the religion spread to the Visayas and Luzon Islands.

The most powerful ruler was the sultan of Sulu, whose territorial jurisdiction extended to Sabah in North Borneo. Before he took control, the chiefs or the *datus* governed the political communities. Their advisers were the *tuan* (nobles), the *shaik* (religious personages), and the *orangkaya* (men of means).

Islamic society absorbed the old system. But only descendants of the first sultan could be candidates for the sultanate. As well as occupying the highest political position, the sultan was also the leader and protector of Islam in his realm.

The chief minister *(datu bendahara)* was the sultan's closest adviser. He assisted him in the negotiation of treaties and adjudication of cases. Another important official was the *datu mamamsha*, who was the guardian of customary law and the spokesman for the ancient rights of the *datus*.

The highest officials, along with the heir apparent (the *raja muda*) and the royal *datus*, made up the *Ruma Bichara*. This body discussed laws, treaties and policies that the sultan had put forward. The Muslim communities of Mindanao and Sulu were never fully conquered, continuing their resistance to foreign rule throughout the Spanish and American colonial periods.

**The Spanish period.** During the Spanish colonial period, which lasted from the 1500's to the 1800's, the governor general represented the Spanish monarch. He had wide powers over colonial officials and the population. The governor general published and enforced laws, decrees, and orders from the Spanish ministries. He could also suspend them if he believed that this was in the public interest.

Until 1861, the governor general was also president of the *Audiencia*, or the Supreme Court. Being the supervisor of all government agencies and head of the armed forces, he had the power to punish any public or military official.

Theoretically, the governor general had to account to the ministries at home in Spain and to the minister of colonies. But, because the colonial inspection system was never fully completed, he had complete freedom in performing his functions. The *Residencia*, Board of Authorities and the Council of Administration were only

**Malacañang Palace,** in Manila, is the elegant official residence of the president of the Philippines.

consultative bodies. The only effective check came from the Catholic Church.

The director general was the highest civil administrator. He was in charge of the heads of administrative bureaus and oversaw the management of local governments.

The *alcalde-mayor* (provincial civil governor) governed the civil provinces, while the *corregidores* (military governors) controlled the military provinces. Both had executive and judicial powers and were appointed by the Spanish government.

The *gobernadorcillo* (town mayor) administered the *pueblos* (towns) while the *barrios* (villages) were under the *cabeza de barangay.* Their main task was the collection of taxes, the inspection of schools, and the entertainment of visiting officials.

**The American period.** The Americans took over from the Spanish in 1898. The highest authority under the new American rulers was the Philippine Commission. Until 1901 all the members were Americans. The American governor general was the chairman of the commission, which had both executive and legislative authority.

The Philippine Assembly first met in 1907. The body consisted of Filipinos, and had limited powers. It had to share its lawmaking functions with the American-dominated Commission. The Assembly had no jurisdiction over the non-Christian areas of the country. In 1913, the Americans gave Filipinos control of the Philippine Commission. The president of the United States appointed the commissioners and other high officers of the central government, and they were responsible to him.

From 1913, more Filipinos gained government posts. The original policy had aimed at a gradual substitution of Filipinos for American clerical personnel. But the number of permanent American administrators declined rapidly, and Filipinos took up administrative positions ahead of schedule.

In 1916, the Philippine Autonomy Act (commonly known as the Jones Law), was passed. It created a two-chamber Congress, whose members were elected by the people. The exceptions were two members of the Senate and nine members of the House of Representatives, who were appointed by the governor general to represent the non-Christian provinces.

But the practical extent of Filipino power depended on the attitude of the governor general. Moreover, most members of the Supreme Court were Americans, appointed by the president of the United States.

In 1934, the U.S. Congress passed the Tydings-McDuffie Law, authorizing Filipinos to frame their own constitution. It also provided for the establishment of the Commonwealth of the Philippines, to be followed 10 years afterward by the inauguration of the Philippine Republic.

The Constitutional Convention first met on July 30, 1934. It took six months to finish the framing of the Constitution, which was approved in a referendum on May 14, 1935.

In September 1935, there were elections for president and vice president of the Commonwealth, and for members of the National Assembly. The voters elected Manuel Luis Quezon as president and Sergio Osmeña as vice president.

During the Commonwealth period, the United States Congress had absolute control over the Philippines. Acts framed by the Philippines Congress relating to imports, exports, immigration, currency, and coinage required the approval of the United States president before they could become law. Foreign loans and constitutional amendments also needed such approval. The United States also retained control of the foreign affairs of the country. The United States could also intervene in the Philippines for the reasons laid down in the Tydings-McDuffie Law.

**The Japanese period.** After Japanese forces invaded the country in December 1941 during World War II, they established an executive commission composed of Filipino officials. Later, they formed the Central Administrative Organization with six executive departments. A Filipino commissioner headed each department, supported by Japanese advisers and by the Council of State.

In September 1943, the Preparatory Commission for Philippine Independence framed a constitution which proposed a *unicameral* (single-chamber) National Assembly. The members of the new assembly elected José Laurel as president of the republic. The following month, the Philippines declared independence and became a republic. Laurel immediately set about encouraging nationalism. He promoted the Tagalog language and Philippine culture. Only Filipinos could teach Tagalog, Philippine history, and character education. In spite of this push toward nationalism, the Japanese were in actual control of the government. Their atrocities brought great suffering and caused fierce resistance from the Philippine people.

**The postwar period** brought complete independence to the Philippines in 1946. The years 1946 to 1966 were politically stable ones. The government crushed a rebellion by the Communist Party in the early 1950's. Until the mid-1960's, the major issue was graft and corruption. But unrest began to surface once more in rural areas because Congress neglected agricultural problems. Moreover, 1968 saw the rise of a new Communist party, with young leaders. In 1969, the voters reelected Ferdinand Marcos as president. In the 1970's, the oppo-

sition, led by Senators Jovito Salonga and Benigno Aquino, began to denounce the president's authoritarian regime. At the same time, three political groups posed a serious challenge to the government: the New People's Army of the Communist Party; the Moro National Liberation Front (a Muslim movement seeking independence from the Philippines); and an alliance of students, workers, and intellectuals.

In 1971, the government established a constitutional convention, with the aim of restoring confidence in the political system. A few convention delegates had progressive views, but the majority had the same big business and landowning backgrounds as their counterparts in Congress. The credibility of the convention suffered when a delegate revealed that many colleagues were on the secret payroll of the government.

Demonstrations and marches against the government increased. At a Liberal Party rally, grenades injured senatorial candidates. President Marcos subsequently suspended the writ of habeas corpus.

**The authoritarian period.** On Sept. 21, 1972, the president proclaimed martial law throughout the country and suspended the 1935 Constitution. The constitutional convention had completed its task, and submitted the new constitution to the president. This constitution took effect in January 1973.

The 1973 Constitution established a parliamentary system of government in which the members of the National Assembly elected the prime minister. In practice, the prime minister under the Marcos regime was elected by the Executive Committee, which was appointed by the president. The extensive powers enjoyed by the president also weakened the position of the prime minister as leader of the Cabinet and the National Assembly. The president issued decrees that did not require the approval of the Assembly.

In October 1976, a referendum approved amendments to the 1973 Constitution which confirmed the president's authoritarian powers. Additional referendums were conducted in January 1980 and April 1981, and approved further changes in the Constitution. In January 1984, there were further extensive amendments, including a provision which would allow Imelda Marcos to succeed her husband. Despite the lifting of martial law in 1981, the authoritarian regime continued. In August 1983, Benigno Aquino was assassinated. This incident caused a serious economic and political crisis. Recession, a high rate of unemployment, runaway inflation, and the devaluation of the national currency combined to erode living standards and the people's confidence in the government and the economy.

A considerable number of opposition candidates won National Assembly seats in the election of 1984, although the ruling party retained the majority. There was a marked increase in guerrilla activities, such as ambushes of government convoys, raids on military camps and assassinations of public officials. Controversy raged over allegations of hidden wealth belonging to top officials. The National Assembly opposition filed an impeachment resolution against President Marcos for "graft and corruption, culpable violation of the Constitution and gross violation of his oath of office, and other high crimes." The ruling party proposed that elections for the presidency should take place in February 1986.

The resistance to the Marcos regime came mainly from underground groups. There was also widespread unrest in the countryside. The strength of the New People's Army increased significantly as a result of harsh military treatment of villagers.

Eventually church-related groups, professionals, and the business community also began to demand the restoration of democracy. The momentum of public protest led to the hurried calling of presidential elections and the revolution of February 1986, which forced President Marcos to go into exile.

**The post-Marcos period.** Corazon Aquino, widow of Benigno Aquino, became the new president. She proclaimed the Freedom Constitution, which was an adaptation of the 1973 Constitution. On May 25, 1986, Aquino appointed 48 members to a constitutional commission, which was to draft the new basic law. The commission conducted public hearings throughout the country. There were heated debates on such fundamental issues as the national economy, social justice, and foreign policy. The final draft was eventually approved in October 1986.

The constitutional commission launched a nationwide education campaign on the draft constitution from November 1986 to January 1987. In the referendum of February 1987, an overwhelming majority of voters approved the document. The new Congress first met in July, 1987.

At the presidential election in May 1992, General Fidel Ramos was elected with 23 per cent of the vote. He was inaugurated as president on June 30.

**Related articles** in *World Book* include:

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**Outline**

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- D. The American period
- E. The Japanese period
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- G. The authoritarian period
- H. The post-Marcos period

**Questions**

What qualifications must a president of the Philippines have?
What are the names of the two houses of Congress in the Philippines?
Which bills can a president veto?
What is the name of the highest court in the Philippines?
Which country has the Philippines followed in developing its political system?
What was the name of the first constitution of the Philippines?
What was the basic political unit during the precolonial era in the Philippines?
When did the religion of Islam arrive in the Philippines?
In what year was President Marcos forced to go into exile?

**Native Filipino people**

**The Spanish period**

**Defeat of Marcos**

**The history of the Philippines** has included waves of immigration. The first immigrant peoples were ancestors of modern Negritos, *left.* The Spanish period started with the arrival of Magellan, *centre.* Massive public demonstrations achieved the overthrow of Marcos, *right,* in 1986.

**Philippines, History of the,** is the story of a nation of many different groups of people living on more than 7,000 islands. For most of the country's history, these groups were geographically isolated from each other. They were separated not only by sea, but also by rivers and mountain ranges. They spoke a number of different languages and developed their own different cultural and social traditions.

The groups did not become one nation until after the Spanish arrived in the 1500's. The period of Filipino history before 1521 is known as the *pre-Hispanic era.* When the Spaniards settled in the Philippines, they introduced a centralized form of government and Roman Catholic Christianity. Both had a unifying effect on the scattered groups. But even today the unity of the Filipino nation is fragile. A number of political, regional, or religious groups such as the Muslim people of southern Philippines have tried to break away. Such groups unsuccessfully opposed the central government based in Manila, the national capital.

Archaeologists have found evidence that people lived in the Philippines as much as 400,000 to 500,000 years ago. More than 50,000 years ago, people from the mainland of Asia began to arrive in the Philippines. Anthropologists believe they came to the islands from southern China. These immigrants included groups of people called *Negritos.* Their descendants still live in the Philippines but these dark-skinned people make up only a small proportion of the population. About 3000 B.C., groups of Malays from Malaysia and Indonesia began to settle along the coasts of the islands. These people are the ancestors of most modern Filipinos.

The Spanish period lasted for more than 300 years. It began in 1565, when the first Spanish settlement was established in Cebu. It ended in 1898 when the Filipino leader Emilio Aguinaldo proclaimed his country's independence and established the first Republic of the Philippines.

This republic was short-lived. A period of war among the Filipinos, the Spanish, and the Americans broke out in 1896. The fighting ended in 1898 when the United States bought the Islands from Spain for a sum of 20 million U.S. dollars.

America continued to control the Philippines until Japan invaded the country in December 1941 during World War II. Japan granted the Philippines independence on Oct. 14, 1943, and established the second Philippine republic.

American troops returned to the Philippines in October 1944 and defeated the Japanese within six months. The Philippines gained complete independence on July 4, 1946. From a Filipino point of view this act was the restoration of independence which the United States had taken from the Philippines by force in 1898.

The post-war period extends from 1945 to the present day. During this time, several presidents have headed the government of the country. President Ferdinand Marcos declared *martial law* (military rule) on Sept. 21, 1972. In 1986, a popular people's revolution swept Marcos from power and forced him to leave the country. Cory Aquino, the country's first woman president, then took over as the country's leader.

## The earliest times

**The first people** may have lived in the Philippines as early as 400,000 to 500,000 years ago. Archaeologists have found evidence that people lived in the provinces of Palawan and Cagayan about that time, and there were certainly people on the Asian mainland. Geological evidence indicates that at that time the islands of the Philippines were joined to the Asian mainland by land bridges. The sea level was lower than it is today because the earth was in the grip of *ice ages*. (See **Ice age**).

Archaeologists have also found some evidence that later people began arriving in the Philippines about 50,000 years ago. They believe that these people travelled from southern China by walking across land bridges.

Anthropologists have been able to build up a picture of the lives of these early inhabitants from evidence found in the provinces of Cagayan and Palawan. In 1962, archaeologists discovered stone tools and other objects dating from about 20,000 years ago, in Tabon Cave, Palawan province. They also found some other stone objects that were considerably older, indicating that the caves had been lived in for many thousands of years earlier.

From the scanty evidence available, anthropologists can only imagine how these early people lived. Studies of the positions of cooking fires and of objects made by humans indicate that only one family lived in Tabon Cave at any one time. A typical family probably consisted of about 30 or 40 people.

The Tabon people hunted animals and gathered food from wild plants. Archaeological discoveries indicate that many Tabon people, and their relatives in the Cagayan Valley, lived in the open. But some Tabon people also lived in caves which provided them with excellent shelter. The Tabon people also ate bats that inhabited the caves.

These early people knew how to make and use stone-flake tools. The tools were about 5 centimetres long and had sharp, double edges. They were used for making other tools and for scraping. Some people also made bigger tools and weapons. The men of the Cagayan Valley used such weapons to hunt large animals, including elephants. Weapons found in the Tabon Cave were much smaller and were evidently used to hunt bats and birds.

**The pre-Hispanic era.** Early Philippine settlements were near the sea and along rivers. Such communities served as meeting points not only with other Philippine tribes, but also with traders from China, Japan, and other neighbouring countries. Political, cultural, and religious ideas were exchanged as well as a variety of merchandise.

The lifestyle of the people varied from one place to another. Human shelter in the lowland areas, for example, took the form of the *nipa hut*. This was a small structure made of bamboo or wooden posts, with flattened bamboo or wooden walls, and roofed with *nipa* (palm) or *cogon* (coarse grass).

The aboriginal Negrito tribes lived in temporary *lean-*

**Important dates in the Philippines**

- **c.50,000 B.C.** People from Southern China began to arrive in the Philippines.
- **c.3000 B.C.** Malays from Indonesia and Malaysia began to arrive in the Philippines.
- **A.D. c.1380** The Arabian missionary scholar Mudum first brought Islam to the Philippines.
- **1521** Ferdinand Magellan landed in the Philippines.
- **1543** Ruy de Villalobos gave the name *Filipinas* to the islands now known as Samar and Leyte.
- **1565** Spanish explorers claimed the Philippines for Spain and established a permanent settlement.
- **1896** The Spaniards executed José Rizal, a leader of the Philippine independence movement. Emilio Aguinaldo led a revolt against the Spaniards.
- **1898** Emilio Aguinaldo established the first Philippine Republic on June 12 and it was declared independent. The U.S.A. ended the Spanish-American War by defeating Spanish forces in the Battle of Manila on August 13. Spain ceded the Philippines to the U.S.A. in the Treaty of Paris signed on December 10.
- **1935** The Philippines became a commonwealth, with Manuel Quezon as its first president.
- **1942-1945** Japan controlled the Philippines.
- **1946** The Republic of the Philippines was established.
- **1954** The Philippine Army defeated the Communist-led Huk rebels after a five-year fight.
- **1972** President Ferdinand Marcos declared a state of martial law, which lasted until 1981.
- **1986** Widespread protests against Marcos forced him to leave office, and Cory Aquino became president.

**Igorot people** made this vessel with its beautifully moulded decoration of an Igorot family group.

*tos.* These were fragile structures built from leaves, and put up at random as they roamed the jungle in search of food. The Negritos had a simple culture. Although they used rather primitive bows and arrows, their knowledge of forest plants and animals was quite extensive.

Other tribes that later arrived in the Philippines developed different ways of living. The Ilongots of northern Luzon built their boxlike homes in tree tops. This was to protect them from wild animals and human enemies. On the island of Mindanao, tribes such as the Badjaos built their homes on stilts near the sea or in rivers. These houses were modified versions of the nipa hut.

As a result of contact with other cultures such as Muslim Indonesia, some Muslim tribes in Mindanao built *longhouses* to accommodate their parents, grandparents, and children, as well as other more distant relatives.

The culture of the early Filipinos in the other islands varied according to their contact with the outside world. Most cultures included some form of the *barangay.* This was a group of 30 to 100 families concerned with social and political matters. It was headed by a chieftain chosen for his wealth, bravery in battle, or age and wisdom. The barangay was named after the type of boat that carried the first immigrants from the south to the Philippines.

Early Filipino society was composed of the nobility, the ordinary men, and the servant or slave class. The men practised a simple form of democracy. Every man in the village had a say in matters affecting him. He took part in all types of village activities. He joined other men to fish and hunt, and helped build and repair the homes of his relatives. He also took part in wars against other barangays.

The early Filipino people adjusted well to their environment. In the Bicol region, they mined gold. In most places men farmed and built irrigation systems. The women wove textiles with locally grown cotton.

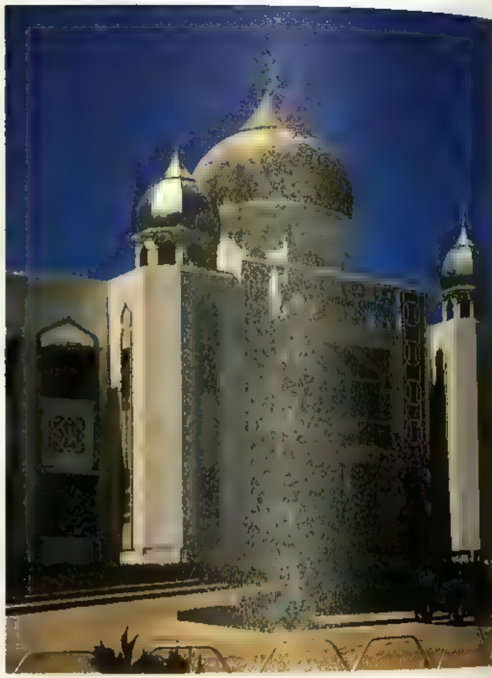
In the remote mountain regions, the men wore a *loincloth* (covering between the legs), and the women wore skirts. In other areas, such as Muslim Mindanao, people wore highly colourful textiles which served as skirts either for men or women.

The early Filipinos had their own religions. They believed in spirits and spiritual beings who controlled their lives and their activities. They also believed in life after death. In most tribes, religious practices were conducted by priestesses. When a person fell ill, the priestess acted as a go-between for the patient and the spirits.

The Filipinos also expressed their feelings in literature. Their literature included songs, tales, legends, proverbs, and long epic poems which praised their heroes. Although they had their own form of writing, based on a South Indian script, their literature was handed down from one generation to the next by word of mouth.

Women held a high position in precolonial Filipino society. They inherited property from their families and from their dead husbands. A woman could become the chieftain of a village in the absence of a male successor. Women played a major role in preserving Filipino culture and passing it on to their children.

In places influenced by Islam, women did not have the same rights as men. Today, that inequality is disappearing in the Philippines and there are now Muslim women government officials, judges, and professionals who have much influence.



**Sulu Provincial Capitol** is in Jolo, on Jolo Island. Its architecture reflects over 600 years of Islamic influence.

In precolonial Philippines, most of the land was commonly owned by villagers. In Muslim regions, land was privately owned by the chieftains, sultans, and *datus* (local headmen).

The earliest contact the Philippines had with Islam was through Muslim Chinese merchants. In about 1380, the Arabian scholar Mudum went to Sulu to preach the Islamic faith. In 1390, a Sumatran named Rajah Baginda arrived in Sulu and converted the natives to Islam. Some time later Abu Bakr, a native of Palembang, also arrived in Sulu to preach Islam. Abu Bakr married Baginda's daughter.

After Baginda's death, Abu Bakr became sultan. He set up a government patterned after the sultanate of Arabia. But it was Serif Kabungsuan, from Johor, who preached and established Islam in Mindanao. He is generally regarded as the first sultan of Mindanao.

Apart from the common Muslim practices shared with the Islamic world, many pre-colonial Filipino Muslims secretly held on to their old religious beliefs such as *animism* (the belief that natural objects have souls), and the worship of spirits. In this way, they practised a kind of folk Islam. Even so, the Islamic religion attracted many followers not only in Sulu and Mindanao, but also in the Visayas, and even in Luzon. Immediately before the Spaniards arrived in the 1560's, Manila became an Islamic settlement. Sulayman, ruler of Manila, was related to the royal family in Borneo. The arrival and settlement of Spaniards in the Philippines prevented Islam from spreading to all the other islands.

## The Spanish period

**The Spanish conquest.** The first contact between Spain and the Philippines came about with the arrival of Ferdinand Magellan in 1521.

Magellan was a Portuguese navigator who became a Spanish subject. Under the patronage of Spain's King Charles I, Magellan sailed from Sanlucar, near Seville in Spain with five ships and 237 men on Sept. 20, 1519. Magellan wanted to show that he could arrive in the east by sailing westward. He hoped to prove that the world was round, and not flat as many people believed. He crossed the Atlantic, rounded the western coast of South America, and went on to sail across the Pacific.

Magellan's voyage lasted a year and a half. During that time, he and his crew suffered great hardship including hunger, thirst, disease, mutinies, and other misfortunes.

Magellan and his men first sighted the island of Samar on March 16, 1521. From there they sailed on to Masaua, south of Leyte, where they exchanged gifts with the local chiefs. A priest who was with Magellan's expedition held the first Catholic mass on Philippine soil on Easter Sunday, 1521. Magellan and his men went on to Zugbo (Cebu), where they announced their arrival by firing cannons. They later informed Humabon, the chieftain, that they had come only to visit and buy food.

Magellan made a *sandugo* (blood compact) with Humabon. Humabon, his wife, and his children were baptized. People from Zugbo and other nearby islands were also baptized.

Magellan became involved in local politics and was killed in a battle against Lapulapu, Humabon's chief enemy. His men escaped in the one remaining ship, and sailed back to Spain. They arrived home in September 1522. Of the 237 men who had started the voyage, only 18 returned.

Other expeditions were fitted out for the Philippines. Among these was one headed by Ruy de Villalobos. He started out from Navidad, Mexico, in 1542. It was Villalobos who gave the name *Filipinas* (Philippines) to the Samar-Leyte region. The name, which was chosen to honour King Philip II of Spain, was later applied to all the islands.

Every one of the expeditions that followed Magellan's voyage ended in failure. Not until 1565 did the Spaniards succeed in establishing a permanent settlement in the Philippines. In that year, Miguel López de Legazpi, who had sailed to the area from Mexico, arrived and settled in Cebu.

Legazpi arrived in four ships with 400 men, including five Augustinian friars. The expedition was reinforced by 200 soldiers in 1567. With tact, resourcefulness, and courage, Legazpi won over the local people. Before long, he had established settlements in other parts of the country. Manila was a Muslim settlement ruled by Sulayman, and located in what is today Fort Santiago. In 1570, Legazpi's second-in-command, Martín de Goiti, captured the settlement. By the following year, Manila had become a Christian city.

From Manila, Spanish forces were sent to other parts of Luzon. The Spaniards were so successful in their campaigns that by the time of Legazpi's death in 1572, many of the islands had passed into Spanish rule.

The Portuguese, Dutch, and Chinese continued to fight the Spaniards during their colonial period but were repelled. As a result, the Philippines remained a Spanish colony.

With Spanish colonial rule, there were several changes in the Philippines. The Christian faith replaced precolonial religions, except for Muslim areas in Mindanao, and the jungle and mountain areas in Luzon and the Visayas. This was achieved mainly through the work of zealous missionaries. Their work was aided by certain aspects of pre-Spanish Philippine religions which resembled Christianity. The precolonial Supreme Being, Bathala, was similar to the Christians' God. And the pre-Spanish *anitos* (deities and spirits) had their counterparts in the Christian angels and patron saints. With Christianity came the abolition of slavery, *polygamy* (marriage to more than one woman at the same time), and *infanticide* (the killing of babies). There were other changes. The Spaniards brought the Roman alphabet and printing press. They also introduced western

**Magellan** died on the shore of Mactan Island, killed by Lapulapu and his men in April 1521. He was one of the first Europeans to reach the Philippines. One of his five ships, the *Victoria*, became the first to sail round the world.

music, painting, sculpture, and literature into the islands. They built schools, churches, and hospitals. Western influence became apparent in the clothes, and in the manners, and behaviour of the people.

With a central government in Manila, the islands were gradually brought together to form a nation known as *Filipinas.* The governor general, appointed by the Spanish king, ruled all the islands. He had full power over the laws of the land, courts, treasury, armed forces, and even the Church. The Supreme Court of the colony, which was known as the *Royal Audiencia,* was also established.

Provincial and local government was at first controlled by men who ruled various *encomiendas* (land granted to individuals for service to the king). These men were later replaced by *alcaldes-mayores* (provincial civil governors) in peaceful provinces, and by *corregidores* (military governors) where conflict still lingered. The Spaniards also established towns. These were ruled by *gobernadorcillos* (town mayors), who were elected by prominent citizens under the supervision of the parish priests.

The Spanish conquerors, with the help of the local people, built bridges, roads, fortifications, ports, and other public improvements. They imported new plants and farm animals from the Americas to meet the needs of the colony. Industries such as cigarette factories were started up by the colonizers.

However, Christianity and Spanish rule were strongly opposed in Sulu and Mindanao, mainly because of Muslim hostility. As a result, there was a continuous state of warfare between the Spaniards and Muslims. This warfare lasted almost till the end of Spanish colonial rule in the late 1800's.

The Manila government sent many expeditions to Mindanao and Sulu in an attempt to bring the Muslims under their control. But they all ended in failure. Such actions increased the hostility of the Muslims not only to the Spaniards, but also to Christian Filipinos. As a result, the Muslims frequently raided the coastal towns of Luzon and Visayas. During the raids, Christian Filipinos were captured and sold as slaves in the Southeast Asian market. Among the reasons for Muslim success were the unifying quality of Islam and the rule of the Sultan of Sulu.

**The church at Candon,** in Luzon, is one of many fine Roman Catholic churches built during the Spanish colonial rule.

**Commerce and trade.** In order to raise more money within the colony, the Spaniards took control over the supply of tobacco and other products such as gunpowder, playing cards, vinegar, and opium. Their control of tobacco finally came to an end in 1882, when Filipino workers defied the government and factory bosses because of harsh treatment. As a result, the tobacco industry was greatly weakened for many years. On the other hand, *galleon* or shipping trade between Manila and Acapulco in Mexico flourished, especially during the 1600's and 1700's. But only the Spanish and Chinese merchants benefited from the trade. The merchandise was bought from the Chinese merchants and shipped to

**The galleon trade** lasted more than 200 years. Controlled by Spanish officials, it traded Chinese produce for Mexican silver. Spain also used the galleons to introduce new crops and domestic animals to the Philippines.

Mexico on galleons. There was much corruption among the Spanish officials who controlled the merchandise. On the journey back to Asia, the galleons carried silver, which was highly valued in China.

Filipinos were also involved in the trade as shipbuilders and as crew on the galleons. Filipino labourers cut timber and hauled it from the forests to build galleons in Cavite. They also built other galleons in the provinces of Albay, Camarines, Mindoro, and Pangasinan. The building of galleons destroyed Philippine forests, many of which were stripped because of the heavy demand for timber.

The economy of the Philippines depended almost entirely on the galleon trade. When galleons were lost at sea or captured by pirates the economy suffered. But the galleon trade also brought benefits to the Philippines. It introduced from Mexico such crops as avocados, mangoes, and pineapples, and domestic animals, such as cows and horses. Such new species improved agriculture and domestic livestock.

During the late 1700's and early 1800's, developments inside and outside the Philippines influenced its progress toward nationhood. International trade encouraged growing of hemp, sugar, and other crops for export. The opening of the Suez Canal in 1869 dramatically cut travelling time to Spain. It was easier for Filipinos to visit the mother country, and for Spaniards, many of whom were liberals, to go to the Philippines. As a result of these visits, many important liberal ideas were introduced into the Philippines.

Another development was the emergence and rise of a wealthy middle class. They were mainly Filipino-Spanish or Filipino-Chinese merchants. These people could afford to send their children to the University of Santo Tomás in Manila, or even to European, mainly Spanish, universities.

Soon, communities of Filipino students and young professionals grew up in Spain, Britain, France, and Hong Kong. These students made up the reform or propaganda movement. Among their leaders were José Rizal, Graciano López Jaena, Marcelo H. del Pilar, and Juan and Antonio Luna. They regarded themselves not as belonging to Filipino regional groups, but as Filipinos working to reform their country and people.

Aided by Spanish freemasons and liberals, these young reformists did not want separation from Spain, but demanded the same political rights as Spaniards. In their fortnightly newspaper, *La Solidaridad* (Solidarity), the reformists published articles to advance the Filipino cause.

José Rizal was the most famous of the reformists. As a student in Madrid, and later as a medical doctor, he wrote poems, articles, political tracts, and two novels *Noli Me Tangere* (Touch Me Not) and *El Filibusterismo* (The Subversive). Rizal hoped to make Spaniards aware of the abuses committed against Filipinos by the Spanish government and the Church.

Rizal was later imprisoned for his political beliefs, and after a mock trial, was executed by the Spaniards in 1896. His death merely fanned the flames of rebellion, and led to the Philippine revolution and the Philippine-Spanish War (1896-1898).

**Revolts and uprisings.** Philippine history, from the beginning of Spanish rule to the mid-1800's, was a long tale of revolts and uprisings. Some of the revolts stemmed from personal reasons. In 1744 a man named Francisco Dagohoy led a revolt because a Spanish priest refused to allow his brother to be buried in a Catholic cemetery. The revolt, which was called Dagahoy's Uprising, spread through the island of Bohol, and lasted 85 years. Others rebelled for religious, economic, or political reasons.

**José Rizal** was a young doctor and political reformist whose writings demanded more freedom and equality for Filipinos.

But whatever the initial reasons, the revolts outgrew personal feelings and became matters of national and patriotic concern. Organized resistance was scattered. Without weapons and unified leadership, the uprisings were bound to fail.

Chinese residents added to all difficulties by revolting from time to time. But the most persistent rebels were the Filipinos themselves. They frequently revolted against the abuses and injustices suffered at the hands of the Spaniards.

Between the years 1645 and 1665 alone, five uprisings against the Spanish government occurred. Other revolts, no less serious, took place during the 1700's and 1800's. The uprising of 1872 in Cavite province was specially noted for its size and effect on Philippine history. It was put down with the execution of three priests—Burgos, Gómez, and Zamora—who had earlier worked for reforms within the colonial church. Their work was regarded as subversive by the Spanish authorities. These three priests are today revered as heroes by Filipinos,

and are looked upon as forerunners of Philippine nationalism.

From the 1800's onward, plotting against corrupt government officials and high-handed religious corporations never really stopped. In 1892 Andrés Bonifacio, a working man, organized a secret revolutionary society known as the *Katipunan.* The group whipped up hatred against Church and government abuses, and demanded freedom from Spain.

Several reforms took place during the 1800's, but they were altogether too timid and too late. As a result there was much discontent. In August 1896, the Filipinos rose in revolt and declared themselves independent of Spain. The revolution spread throughout the islands. It was halted by the pact of Biaknabato in December 1897, but was resumed the following year. By 1898, the revolutionaries were being watched and helped by the Americans. The Filipinos succeeded in taking all Philippine territory except for Manila. The Spaniards finally surrendered to the Americans on Aug. 13, 1898, after the Battle of Manila.

### First Philippine Republic

On June 12, 1898, Emilio Aguinaldo, leader of the Filipinos, proclaimed Philippine independence on the balcony of his house in Kawit, Cavite province. The Filipino flag was unfurled, and the national anthem played by a band for the first time. Ambrosio Rianzares Bautista read out the Declaration of Independence which he had written.

Meanwhile, in the United States of America, President William McKinley talked about the need for the U.S.A. to expand. The U.S. government had bought Alaska, and had taken over the Pacific islands of Midway and Pago Pago. The Americans needed new markets for their products, refuelling stations for their ships, and army and naval stations to protect them in times of war. Men such as Vice President Theodore Roosevelt urged McKinley to take over the Philippines. In their ignorance, most Americans, including the president, thought that the Philippines wanted to belong to the U.S.A.

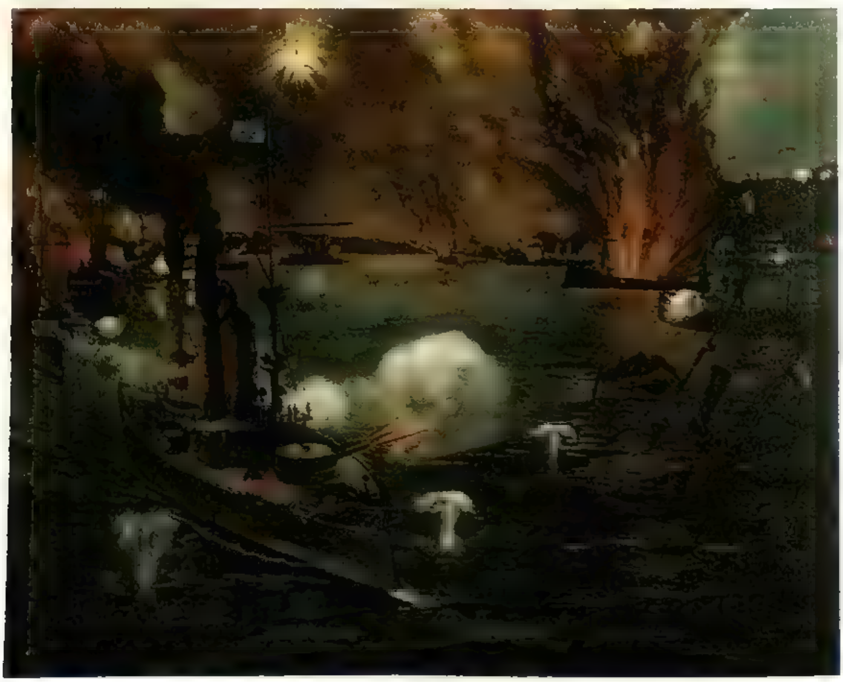
But the Filipinos were busy organizing a new nation. The on-going war with Spain made it impossible to have free elections. For this reason, Aguinaldo appointed delegates from each province to attend a congress in Malolos. He planned to organize a government and draft a constitution. Pedro Paterno, who had negotiated the pact of Biaknabato, was elected president of the congress. The delegates approved a constitution which became official on Jan. 21, 1899. It was clear that the Filipinos wanted to keep their hard-won independence.

### The American period

**Filipino-American War.** Tension began to mount between the Filipino and American armies. On Feb. 4, 1899, an American sentry shot a Filipino soldier who was trying to cross San Juan Bridge, near Manila, into American-held territory. As a result, war broke out between the Philippines and the United States. Two days later, the U.S. Senate voted to take over the Philippines.

The U.S. army had more supplies than the Filipinos. It was trained, better armed, and better disciplined. But the Filipinos fought courageously to protect their freedom. The result was a long and disastrous war. Thousands of soldiers died on both sides. One-sixth of the entire Filipino population perished. Many were soldiers, but there were even more women and children killed by bullets, starvation, and disease. The war also killed cattle and stripped the farms of labourers. As a result, agricultural output was low.

The Filipino leader, Emilio Aguinaldo, surrendered in 1901 and swore allegiance to the United States. In 1902,



**The Battle of Manila Bay** was a defeat for Spain in the Spanish-American War of 1898. On May 1, a squadron of 6 American ships commanded by Commodore George Dewey destroyed the entire Spanish fleet of 10 vessels.

**General Emilio Aguinaldo,** above, and his fellow officers, right, led Filipino forces against the Spanish in the revolution of 1896. Aguinaldo later established, and became the first president of, an independent Philippine Republic.

President Theodore Roosevelt declared an end to the war.

But some revolutionaries continued to fight on. Artemio Ricarte refused to surrender and preferred to go into exile in Japan. General Macario Sakay was not captured until 1906. He vowed to grow his hair until the Philippines regained independence. The Americans declared Sakay a bandit and hanged him.

**The American regime.** Civil government under the Americans was established on July 4, 1901. During subsequent years, the Philippines made strides toward home rule. The Philippine Commission functioned as the upper house. It had a majority of Americans and a minority of Filipinos. In 1907, the Filipinos began to elect members to the lower house. On October 16 of the same year, the members met and chose Sergio Osmeña as speaker.

**Social and cultural changes.** The Americans used education to keep a firm check on the Filipinos and to advance and improve social and cultural conditions. Not long after the end of the war, an American army chaplain, acting as superintendent of schools, established a number of schools in Manila. Soon, schools were established in other parts of the country. The Spaniards had set up a relatively advanced educational system that trained Filipinos for professions, the Church, and positions in government. But it was the Americans who set up education for the masses.

As a result, most people learned to read and write. The death rate dropped as people learnt more about hygiene. The presence of new hospitals and clinics helped cut down diseases and epidemics.

The Americans granted Filipinos the right to free trade. They also encouraged foreign investment in the Philippines, to improve and develop industry and trade. Yet the fire of nationalism within the Philippines burned on. Passive resistance emerged within the religious sector. In 1900, Isabelo de los Reyes started a campaign for the clergy to be Filipino. He also wanted to prevent Spanish friars who had been ousted during the revolution from returning to the Philippines. A movement to sever ties with Rome gathered momentum under Gregorio Aglipay, a former chaplain of the Filipino revolutionary troops.

In 1902, Aglipay became supreme bishop of the Philippine Independence Church, which he had founded with Isabelo de los Reyes. Many Filipino Catholic priests, together with their parishioners, joined the new church. Although they followed the traditional Catholic rituals, they also considered patriotism holy. The Church declared José Rizal, and the three priests Burgos, Gómez, and Zamora, saints.

The Americans brought Protestantism in various forms to the Philippines. Methodists, Episcopalians, Baptists, the Church of Christ, and other religious groups, founded chapels and churches. They also set up schools, hospitals, orphanages, and printing presses, and vigorously spread the Protestant faith.

In order to counteract this Protestant invasion, the American Catholic Church, with encouragement from Rome, sent American priests and religious people to the islands. For a time, all the Catholic bishops of the Philippines—including the archbishop of Manila—were Americans. Later, Catholic missionaries from Germany, Belgium, Canada, and Italy arrived in the Philippines. Together they were able to halt the advance of the Aglipayan and Protestant churches. As a result, the Philippines has remained mainly Catholic to this day.

A more militant nationalism with religious overtones eventually ended in open revolt against the government. Unrest among poor labourers and landless peasants started these uprisings. In 1923 and 1924, a rebel group

**President Manuel Quezon** (left) and General Douglas MacArthur during the time MacArthur served as military adviser to the Philippines. When the Japanese army invaded the Philippines in 1941, MacArthur's troops were no match for the Japanese and within a few months the islands had fallen. MacArthur left the Philippines saying "I shall return", which he did in 1944.

called the *colorums* controlled the government in eastern Mindanao. A peasant revolt in 1927 occurred in Negros, and in 1931, another rebellion took place in Tayug, Pangasinan province. This later rebellion was led by the *Sakdalistas,* a society whose members believed amulets and secret prayers made them invincible against their enemies.

In May 1935, the *Sakdal* (a peasant, socio-political society) rebelled in the Tagalog provinces. This was the last uprising against American rule before the Commonwealth government was established. All the militant groups preached Philippine independence and historians are not certain about the part each played in achieving this aim.

The U.S. Congress passed legislation, called the Jones Law of 1916, promising the Philippines independence. One of the conditions for independence was the establishing of a stable government in the Philippines. The Filipinos worked hard to achieve this, and persistently pressed for early independence. To hasten this goal, they sent several independence missions to the United States.

In 1933, the U.S. Congress passed the Hare-Hawes-Cutting law, aimed at giving independence to the Philippines in 10 years' time. But the Philippine legislature, objecting to some of the bill's contents, rejected it. With the help of Senate President Manuel Quezon, another bill, the Tydings-McDuffie Bill, was passed by the U.S. Congress. It was signed by President Franklin Delano Roosevelt and became law on March 24, 1934. The Philippine legislature accepted it unanimously on May 1 of that same year.

The Tydings-McDuffie Law provided for the calling of a constitutional convention. Its members were elected on July 10. They drafted the constitution for the Philippine Commonwealth, soon to be established, and for the future independent Philippines. The constitution was accepted by the Filipino people on May 14, 1935. Four months later, elections for the president and the vice president of the Commonwealth and members of the one-house National Assembly, were held. Manuel Quezon and Sergio Osmeña were elected president and vice president, respectively. Gil Montilla became speaker of the National Assembly.

**The Commonwealth era.** Amid much pomp and pageantry, the Commonwealth of the Philippines was inaugurated in Manila on Nov. 15, 1935. The years of the Commonwealth were a period of intense preparation for the future independent Philippines. Filipinos had to deal with three main issues that would face them when their country was independent: political stability, national security, and an underdeveloped economy. Although the Philippines was a representative democracy, political power remained in the hands of a few political leaders. This power needed to be spread out more evenly among those in government.

National security and defence took a back seat because Filipinos relied on U.S. military support and because of other more urgent problems. But when Japan began its southward push in the late 1930's in search of raw materials and new territory for its large population, people in the Philippines became alarmed.

Quezon soon saw the need for an army to defend the Philippines in case of attack. He hired General Douglas MacArthur, who had recently retired as Chief of Staff of the U.S. Army, to carry out this important task. MacArthur planned to train a citizens' army of 400,000 reserve soldiers by the end of the Commonwealth period. His plan called for preparing a reserve force of 40,000 trained young men each year and a reserve officers' corps of students at colleges and universities.

The Commonwealth also had to deal with an underdeveloped economy. The Philippines economy had been tied to that of the United States for a long time. Fili-

pinos planned to extend the range of their farming produce, develop their natural resources, expand their domestic trade, increase their industrial strength, and seek new markets outside the United States.

Equally pressing problems existed in the social and cultural spheres. A few people were very rich while many were very poor. This led to widespread discontent, which gave rise to various uprisings. The ruling classes showed little interest in these problems. Quezon, disturbed by the inequality of wealth, introduced a social justice programme. This granted justice to the common *tao* (peasant), giving better living and working conditions, and pay.

The problem of a national language was also one of Quezon's worries. According to the constitution, the National Assembly was to develop and adopt a common language for the Philippines based on the existing language. Toward this end, the Institute of National Language was formed. In November 1937, the Institute recommended the adoption of Tagalog as the basis of the national language. In December, this became law.

The Filipinos proved competent in preparing themselves for their eventual independence. It was to have been granted on July 4, 1946. However, Japanese occupation of the Philippines from 1942 to 1945 temporarily disrupted the timetable.

### Japanese occupation

Some Japanese had settled in the Philippines during the pre-Hispanic and Spanish periods. But it was not until the American occupation that the Japanese arrived in large numbers. Most of them settled in Mindanao. About 30,000 Japanese immigrants were living in the Philippines just before World War II (1939-1945).

The Japanese bombed Pearl Harbor, Hawaii, U.S.A., on Dec. 7, 1941. Almost simultaneously, Japanese planes bombed various army, naval, and air force installations in Luzon and Mindanao. They destroyed all the American Air Force installations at Clark Air Base.

The Japanese landed in many parts of the Philippines, further weakening Philippine defences. Bataan, where American and Filipino troops sought refuge from the Japanese, fell on April 9, 1942. On May 6, the fortress of Corregidor surrendered. Quezon and MacArthur had retreated to Corregidor, and, with some of their staff, managed to escape by submarine to Australia. They later went to the United States, where Quezon established the Commonwealth government-in-exile.

After the surrender of American and Filipino troops, the Japanese set up a military government in January 1942. At first, General Homma, commander of the Japanese troops, announced that all laws of the Commonwealth would remain in force, and that government officials should remain at their posts. But the Japanese soon established an executive commission, headed by Jorge Vargas. Vargas had earlier been appointed (by Quezon) mayor of the greater Manila area.

As head of the executive commission, Vargas had control over all government departments. The commission approved the guidelines of the new regime. Former government employees were to continue in office, and the government machinery was to be streamlined. Provincial and local government officials were ordered to organize neighbourhood associations. Comprising at least 10 families each, these associations were to cooperate with the Japanese army in fighting anti-Japanese activities. They were to distribute rice, soap, matches, and other basic necessities, and were instructed to maintain peace and order.


**Freedom-loving Filipinos** fought the Japanese invaders. American posters encouraged guerrilla bands to resist.

Nevertheless, many Filipino guerrilla groups roamed the countryside, and even appeared in some provincial towns. When captured by the Japanese, the guerrillas were brutally treated, and in many instances executed. Among the guerrilla victims were young teenagers. With the semblance of peace established, Japanese officials promised independence to the Philippines in 1943.

In December 1942, the Japanese announced the dissolution of political parties. In their place, the *Kalibapi* (Association for Service to the New Philippines) was formed. The Kalibapi coordinated all the social, spiritual, physical, cultural, and economic activities of the people. It was also actively involved in preparations for Philippine independence, including the drafting and approval of the Philippine constitution.

In September 1943, delegates of the National Assembly were elected. They chose José P. Laurel as president of the republic. Finally, on Oct. 14, 1943, Philippine independence was proclaimed and José P. Laurel was inaugurated president.

But in spite of this so-called independence, many wartime problems continued to plague the Philippines.

The people were short of food, clothing, and other basic necessities. There were many diseases and few medicines. Hundreds of Filipinos suffered Japanese atrocities and brutality.

Meanwhile, Quezon headed the Commonwealth government-in-exile in Washington, D.C., with Sergio Osmeña and other Filipino leaders who had escaped with him. Many of the 8,000 Filipinos living in the United States at that time joined the U.S. Army. The first Filipino Infantry Batallion was formed in anticipation of the U.S. Army's return to the Philippines.

In the Philippines, people continued to look forward to the Americans' return. Guerrilla bands led by Filipinos and Americans kept the Filipinos' love of freedom and democracy alive. Marcos V. Agustín, later known by his wartime name of Marking, organized one of the more successful guerrilla bands. In its ranks were soldiers, writers, lawyers, labourers, rig drivers, inmates of a reformatory, and a few ex-convicts. Marking's band sabotaged the Japanese, collected intelligence, and spread propaganda.

Two young cadets from the Philippine Military Academy, Eleuterio Adevoso (later known as Terry Magtanggol) and Miguel Ver, established the Hunters ROTC guerrilla group. Stationed in the hills of Antipolo, Rizal province, they destroyed bridges and roads, and attacked Japanese convoys. They also maintained an effective network of espionage and intelligence.

The *Hukbo ng Bayan Laban sa Hapon* (The People's Army Against the Japanese) was a guerrilla unit in central Luzon. This unit was better known as the *Hukbalahap,* and its members were called the *Huks.* The organization was said to be communist-inspired, if not communist-led. The Hukbalahap soon spread over the whole of central Luzon. Most members were peasants and labourers, but some intellectuals, such as the American-trained chemist Vicente Lava, joined the movement. About half a million civilians protected the Huks from the Japanese and supported Hukbalahap activities against the enemy. The Huks claimed to have killed 20,000 Japanese and 1,000 pro-Japanese Filipinos.

The Vinzons guerrillas of the Bicol region in southern Luzon were led by Wenceslao Vinzons. A student leader at the University of the Philippines before the war, Vinzons became a folk hero when he dared to oppose the great Manuel L. Quezon. Vinzons was eventually elected to the Philippine legislature. Vinzons organized his guerrilla group in July 1942. Although most members were civilians, there were also some soldiers whose units had been dissolved. They attacked garrisons, killing Japanese and taking some prisoners. Vinzons was later captured by the Japanese and executed.

Mindanao guerrillas were under the command of Lieutenant Colonel Wendell W. Fertig. He organized guerrilla units in northern Mindanao. The Japanese only ruled the big towns in Mindanao Island. The rest of the island was controlled by the guerrillas. This made it possible for Fertig to organize civil government in those areas. The civilian population cooperated with the guerrillas by giving them food, clothing, and medicine, and by repairing damaged roads and bridges. In return, the guerrillas protected the civilians from Japanese.

On the island of Panay, Colonel Macario Peralta, a Filipino soldier who had served as an officer before the war, formed an all-Filipino guerrilla band known as the Free Panay Force. This unit was better armed than most because it had taken the weapons of the Filipino troops before they surrendered to the Japanese. It maintained an intelligence network covering the whole of Panay Island, and kept in contact with General MacArthur's troops in Australia. Peralta's guerrillas succeeded in driving the Japanese out of the Panay provinces of Iloilo, Antique, and Capiz. They also prepared the ground for the Americans' return to Panay.

Without the aid of guerrillas, return of American troops to the Philippines would have been much more difficult. Ruperto Kangleon, a lieutenant colonel of the Philippine Army before the war, unified the various guerrilla units in Leyte and made contact with MacArthur's troops in Australia. He also established a provincial government in Leyte. The Japanese did their best to suppress the guerrillas. They promised that all guerrillas who surrendered would be pardoned. When this failed, they resorted to torture and violence. Not only were the guerrillas tortured and executed, but in many cases civilians who were suspected of harbouring them were also executed.

But the return of the Americans could not be delayed forever. On June 19, 1944, the Battle of the Philippine Sea began. On September 14, seventy U.S. planes bombarded Manila and neighbouring areas. On October 20, MacArthur, Sergio Osmeña, and his forces landed on the island of Leyte. Sergio Osmeña had been proclaimed president of the Philippines after President Quezon's death in the United States, in 1944.

On Jan. 8, 1945, U.S. troops landed in Lingayen Gulf. Others landed in the northern outskirts of Manila. South of the Pasig, U.S. troops clashed with the retreating Japanese. There was widespread destruction with heavy civilian casualties. By March 3, the last foothold of the Japanese in the historic Intramuros area of Manila was taken. Almost five months later, the whole of Luzon was free of Japanese. Other parts of Visayas and Mindanao were retaken by American and Filipino troops with the aid of guerrillas.

On Aug. 15, 1945, the Japanese officially surrendered to MacArthur's forces at Tokyo Bay, and the Japanese occupation of the Philippines finally ended. The Americans imprisoned José P. Laurel, president of wartime Philippines, and other Filipino collaborators. They remained in prison until their return to the Philippines almost a year later.

### Postwar Philippines

There were many problems facing the Philippines after the war. Ruined cities and towns had to be rebuilt, industry and commerce had to be reestablished, and the country's economy needed to recover.

The Americans granted, or restored, independence to the Philippines on July 4, 1946. As an independent nation, the Philippines was expected to stand on its own feet. But economically, politically, and morally the Philippines was in a state of chaos.

**The rule of Roxas.** Manuel Roxas was proclaimed president when the third Philippine Republic was inaugurated in Manila on July 4, 1946. The main problem Roxas faced was to rebuild the country after the devastating war. Private and official bodies in the United

States offered to help. But, it later became obvious that some of the offers had strings attached.

Soon after the inauguration of the Third Philippine Republic, a treaty was signed between the Philippines and the United States. This treaty allowed the United States to keep military bases in the Philippines for security and defence of the Pacific. "Parity rights" were also granted to the Americans. This meant that the Americans would have equal rights to exploit the natural resources of the land.

Roxas died of a heart attack in Clark Field, two years short of the end of his full term as president. In 1948, Vice President Elipdio Quirino succeeded him.

**The Philippines under Quirino.** Quirino was well prepared for the presidency because he had served in the executive and legislative branches of government. But the people misunderstood his aims, and he was eventually blamed for the dishonesty within his administration. A continuing problem was the rebellion by the Hukbalahap. Quirino had talks with the Huk leaders, and promised them a pardon if they surrendered their arms. He also promised to reinstate Huk legislators who had been unseated because they refused to vote for the Parity Rights Bill. But only a few of the Huks took advantage of Quirino's offer.

Ramón Magsaysay, Quirino's defence secretary, decided to handle the situation himself. Under his leadership, and with American support, the Huk rebellion was finally subdued. Magsaysay captured the imagination of both his own people and foreigners. In the elections of 1953, he defeated his former leader, Quirino.

**The Magsaysay era.** When he assumed the presidency in 1954, Ramón Magsaysay started his campaign to restore Filipino confidence in the government. But Magsaysay was equally concerned about the relationship of the Philippines with other countries, especially the United States. He signed defence treaties with the United States, and negotiated other treaties with neighbouring countries, including Japan.

During Magsaysay's time, the South East Asia Treaty Organization (SEATO) was formed. Participating countries were Australia, France, New Zealand, Pakistan, the Philippines, Thailand, the United Kingdom, and the United States. The treaty aimed to improve political and economic relations among member nations, and to defend any of the member countries during a war. In 1957, Magsaysay died in a plane crash. Vice President Carlos P. García took over the presidency.

**President Carlos García.** Carlos García continued the policies that had characterized Magsaysay's administration. García, a member of the Nacionalista Party, was subsequently elected president in his own right. To boost domestic prosperity, García launched his "Filipino First" policy. According to the policy, Filipinos were to be given preferential treatment over foreigners within commerce and industry. García also studied his country's relations with the United States, and reduced the lease on American bases in the Philippines from 99 to 25 years. In the end, García's administration was also accused of corruption. In the elections of 1961, Diosdado Macapagal, his vice president, succeeded him to the presidency.

**The [redacted] of Diosdado Macapagal.** From the beginning of his term, Macapagal campaigned against corruption in public and private life. Many government officials and private citizens were investigated. At the same time, Macapagal took an active interest in raising the living standards of the poor.

Like some of his predecessors, Macapagal strengthened relations with neighbouring countries. This led to the creation of MAPHILINDO, consisting of Malaya, the Philippines, and Indonesia. This group aimed at unifying the Malay peoples. But the alliance was short-lived because of conflict between Indonesia and newly-created Malaysia. Also the Philippines and Malaysia quarelled over Sabah, a region occupying north Borneo and offshore islands.

Macapagal improved relations with other Asian and European countries in efforts to attract foreign trade and investment. But the country's relations with the United States were somewhat strained. This was in part due to the disapproval by the American Congress of the Philippines' war damage claims against the United States. As a result, Macapagal cancelled a state visit to the U.S. and changed Philippine Independence Day from July 4 to June 12. It was on June 12, 1898, that Aguinaldo proclaimed Philippine independence.

In the 1965 presidential election, Ferdinand E. Marcos stood against Macapagal. In a hotly contested election, Marcos was successful.

**The Marcos regime.** Marcos began his term as president by reorganizing the government machinery. By uniting different government offices that carried out

**Ferdinand E. Marcos** was a successful dictator for 15 years, but the Filipino people overthrew him in 1986.

similar functions, Marcos cut out duplication and saved money. He also reduced tension in the area by forming good relations with Malaysia, the People's Republic of China, and other Socialist countries. But the problems of the country grew worse. The crime rate increased, and by the late 1960's restless students were demonstrating in the streets. Growing economic problems matched rising unemployment, and the cost of basic necessities such as food and clothing rose.

Marcos was reelected president in 1969. He was the first Filipino president to be elected for a second term of office. But Marcos could not stop the rising tide of criminality, unemployment, public disorder, and increased prices.

Marcos began a new land reform programme in 1972, to help the poor in rural areas. Under the scheme, peasant farmers would eventually own the land that they tilled. But this programme covered only farms that grew rice and maize. Sugar cane, coconuts, and banana farms owned mostly by Marcos' friends and associates were not included in the reform. The programme failed because rich landowners delayed the changes and there was also a lack of funds.

Student unrest and demonstrations continued. In 1972, the worst flood ever to hit the country caused billions of dollars worth of damage. A Communist uprising and a Muslim separatist movement in Mindanao added to the confusion. To meet the crisis, Marcos imposed martial law over the whole country on Sep. 21, 1972. Marcos then attempted to take the heat out of the situation by describing martial law as the "New Society." Marcos claimed that his regime was spreading wealth more evenly throughout the nation.

An outward show of prosperity followed, with the construction of gleaming public buildings, the ultra-modern Cultural Centre complex in Manila, and new hotels. This all failed to hide mass poverty, rising prices, and surging unemployment. Only Marcos, his friends, and supporters, seemed to be prospering.

In foreign affairs, Marcos continued to maintain friendly relations with the United States. He also opened diplomatic relations with mainland China, the Soviet Union, and with Asian and African Third World countries. Marcos enlisted the help of Islamic states to solve problems with rebellious Muslim groups in the Philippines, such as the Moro National Liberation Front.

Marcos' critics accused him of violating human rights. But Marcos denied these accusations, maintaining that everything was under control in the Philippines. Although most people were doubtful, Marcos insisted that he had lifted martial law on March 12, 1981.

In June 1981, Marcos called for a presidential election. As expected, he won the election and was inaugurated president on June 30, 1981. The constitution was later amended to include provision for a prime minister, but it stipulated that the president was to be chief of state and head of government. César Virata became prime minister and helped to run the day-to-day administration. Marcos took charge of the bigger issues.

Class distinctions split the nation. A small group comprising teachers and government employees formed most of the middle class. An even smaller group, made up of business executives, rich landowners, and professionals, owned most of the country's wealth. But the vast majority of Filipinos were poor slum dwellers, scavengers, peasants, unskilled labourers, and unemployed. Extreme poverty and massive unemployment led to large problems of drunkenness, murder, robbery, and drug addiction, especially in the big cities and towns. The problems were made worse by large numbers of people flocking to the cities looking for work.

Despite such problems, cultural life flourished in the city. Art exhibitions, opera, concerts, ballet, and theatre helped to entertain the rich. National artist awards were given to Filipinos for outstanding contributions to the development of the arts.

Educating the population was one of the government's aims. But very few of those who started school stayed on after the age of 9 because they were too poor to continue. As a result, many young children could neither read nor write. But in higher education the bilingual use of English and Tagalog-based Filipino was somewhat more successful.

The government's continuing conflict with the Communist Party, and with the Muslim rebels, weakened the country's economy. But multinational companies operating in the Philippines continued to make vast profits, which they sent abroad. The nation's foreign debt continued to grow until it ran into billions of U.S. dollars. Many political prisoners remained in jail despite the efforts of local and foreign human rights groups to get them released.

On Aug. 21, 1983, Senator Benigno Aquino was shot as he disembarked from a plane at Manila International Airport. He was returning from a self-imposed exile in the United States. Many people claimed that the Marcos government backed the murder. Ten days later the senator's widow, Corazon "Cory" Aquino, led two million Filipinos in a 10-hour march to her husband's final resting place. The procession showed that Cory Aquino had captured the hearts of her fellow Filipinos.

A hastily called election for the presidency followed in February 1986 upon the urging of the U.S. government. In the elections, Cory Aquino stood for the presidency and all indications implied that she had won. But Marcos was not ready to give up office. Cory Aquino urged the people to protest by civil disobedience.

The U.S. government sent officials to the Philippines and advised sharing political power. But Marcos refused their suggestions. There seemed to be a deadlock. This was broken on Feb. 22, 1986, when the people took to the streets in protest against the Marcos government. Faced with arrest by Marcos and his men, Defence Minister Juan Ponce Enrile and Vice Chief of Staff Fidel Ramos retreated to an army camp near Manila. From there they led rebel troops against Marcos' army.

On February 22, encouraged by Manila's archbishop Cardinal Jaime Sin, hundreds of thousands of civilians gathered in front of the army camp where Enrile and Ramos had sought refuge. They went there to support the rebels, armed with nothing more than rosaries, flowers, religious statues, and pictures. It was a massive show of people power. In the end, this power defeated the armed might of Marcos' tanks and men, who retreated in the face of unarmed, cheering people.

**Cory Aquino in power.** On Feb. 25, 1986, Cory Aquino was inaugurated as president in a clubhouse on the outskirts of Manila. Marcos was also inaugurated as

president in Malacañang. But the army had turned against him. Less than 12 hours later, Marcos, his family, and close associates were on their way to exile. Marcos died in disgrace in Hawaii in 1989.

Among the earliest of Cory Aquino's acts as president was to appoint the 48 members of the constitutional commission. They were charged with putting together a new constitution, which was approved by popular vote in February 1987. The joy that greeted Cory Aquino's coming to power soon gave way to the harsh realities that the country had to face. The opposition of Communists, right wing politicians, and Muslim separatist groups all had to be dealt with. Later, Cory Aquino faced several attempts by the army to overthrow her. She also had to fight government corruption. An increasing crime rate, unemployment, and poverty were further problems. Aquino lacked local and foreign capital to finance much needed projects. Cory Aquino herself remained untouched by all the allegations of corruption that surrounded her government. She tackled many of the problems that faced her country and people.

Between 1991 and 1994, Mount Pinatubo, a volcano on Luzon, erupted many times. The eruptions and the deposits they left caused hundreds of deaths. The deposits also destroyed crops and towns and affected weather patterns worldwide. The U.S. Clark Air Base was buried under ash, and the United States abandoned it. The treaty that allowed the United States to occupy the air base and Subic Bay Naval Station expired in 1992. There was widespread opposition to renewing the agreement, and the Philippine Senate voted against it. The United States withdrew from Subic Bay.

**Fidel Ramos elected.** At the presidential election in May 1992, General Fidel Ramos was elected with 23 per cent of the vote. Although he had served the government under the presidency of Marcos, he later helped Cory Aquino to defeat him and was a minister in her cabinet. He had also helped in the defeat of several attempted coups. Fidel Ramos was inaugurated as president on June 30.

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**Corazon "Cory" Aquino** was president of the Philippines from 1986 to 1992.

**General Fidel Ramos** was elected by popular vote as president of the Philippines in 1992.

### Outline

**I. The earliest times**
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- B. The pre-Hispanic era

**II. The Spanish period**
- A. The Spanish conquest
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- C. Revolts and uprisings

**III. First Philippine Republic**

**IV. The American period**
- A. Filipino-American War
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- D. President Carlos Garcia
- E. The era of Diosdado Macapagal
- F. The Marcos regime
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- H. Fidel Ramos elected

### Questions

In which provinces have archaeologists made important finds?
What was the position of women in Philippine society before the arrival of the Spanish?
In what year did Ferdinand Magellan arrive in the Philippines?
How did the Philippines get its name?
Who was the Philippine patriot executed by the Spanish in 1896?
What was the *Katipunan?*
When was the first Philippine Republic proclaimed?
When did the United States establish a civil government in the Philippines?
In what year was the Third Republic of the Philippines established after World War II?
In what year was President Marcos forced to leave office?

**Philistines** were an ancient people who settled along the coast of Canaan at about the same time that the Israelites were entering the land from the east. The Philistines were part of a larger movement known as the Sea Peoples, who had fled disruptive conditions in the Aegean area near the end of the 1200's B.C. The centre of the Philistine territory was in and around the cities of Gaza, Ashkelon, Ashdod, Ekron, and Gath. This area corresponds to what is now southwestern Israel. The Greeks called this territory *Palestine* after the Philistines.

During the 1100's and 1000's B.C., the Philistines and the Israelites fought many battles. The Philistines had learned the art of smelting iron from the Hittites. This gave them a military and economic advantage over the Israelites. Only after the Israelites anointed Saul as their first king in about 1020 B.C. did they become strong enough to drive the Philistines back. After David became king of Israel in about 1000 B.C., he subdued the Philistines. After about 600 B.C., the Philistines ceased to exist as a distinct people. The word *philistine* today means a person who is indifferent or hostile to the arts.

See also **David** (Early life); **Samson.**

**Phillip, Arthur** (1738-1814), was the first governor of New South Wales, Australia. As governor, he established European settlement in Australia. He also followed a career in the navy, reaching the rank of admiral.

**Early life.** Phillip was born in London, the son of a German-born language teacher. His mother was previously married to a naval officer. Through her connections, a place for Phillip was found in the Greenwich school for the sons of seamen in 1751. He served his apprenticeship as a merchant seaman aboard the *Fortune.*

Phillip joined the British Royal Navy during the Seven Years' War (see **Seven Years' War**). He served during the British capture of Havana, Cuba. In 1763, he retired on half pay as a lieutenant. That same year, he married his first wife, Margaret. But the couple separated by 1769. They had no children. From 1763 to 1774, Phillip spent his time farming. In 1774, he returned to service with the Portuguese navy in the war with Spain. His service with the Portuguese lasted until 1778. In 1781, Phillip was promoted to the rank of captain in the Royal Navy. The first ship under his command was the *Basilisk.* While commander of the *Ariadne,* he became friendly with Philip Gidley King, who later went with him on the First Fleet to Australia.

In 1784, Phillip retired again on half pay. In 1786, he was appointed as the first governor of New South Wales and given command of the First Fleet. He was probably appointed because of his friendship with his Hampshire neighbour, Sir George Ross, who was undersecretary to the treasury. The site selected for the new settlement in New South Wales was Botany Bay. The site had been greatly praised by Sir Joseph Banks, who had accompanied James Cook during his voyage along the east coast of Australia in 1770. The First Fleet consisted of H.M.S. *Sirius* and H.M.S. *Supply,* six transports to carry the convicts, and three supply ships.

**Governor Phillip**


**Phillip established a colony** in the Sydney area early in 1788. Later, he led or ordered expeditions to search for fertile land. He set up a farm near Parramatta in 1789.

**Botany Bay.** The First Fleet arrived in Botany Bay between Jan. 18 and Jan. 20, 1788, after an eight-month voyage from Britain. The fleet carried convicts and marines to guard the prisoners. It also carried provisions, including seeds for planting, livestock, and food supplies to sustain the colony until the first crops were harvested.

Unfortunately, Botany Bay proved to be a poor site to establish the new colony. It had a low-lying, marshy foreshore. The bay close to the shore was too shallow to provide safe anchorage for the ships, and there was no protection from the wind. There was little fresh water. On January 21, Phillip took three long boats north along the coast to search for another site for the settlement.

**To Port Jackson.** Later on January 21, Phillip entered Port Jackson. There he found a natural deepwater harbour that was protected from the wind. Rowing north, he explored Manly Cove, which he so named because of the "confidence and manly behaviour" of Aborigines he saw there. He explored farther, landing at Camp Cove. Finally, his explorations brought him to Sydney Cove. It had a good natural harbour and a running stream of fresh water, which was later to be called the *Tank Stream.* The cove was named in honour of Lord Sydney, the secretary of state for the home office.

Phillip returned to Botany Bay and began to arrange for the fleet to sail north. During this time, a French scientific expedition commanded by Jean La Pérouse arrived. It remained there until March 10. See **La Pérouse, Jean François.**

Arrangements to move the fleet to Sydney Cove had been completed by January 26. Then, the British flag was unfurled and the King's health toasted.

The male convicts and most of the marines went ashore on January 27 and 28. The convicts were set to work felling trees and clearing an area for the new settlement. Tents were erected for shelter, and the stores and provisions were unloaded. Phillip's house, a porta-

**Sydney Cove** was sketched in 1788 by Lieutenant William Bradley, who sailed with the First Fleet in H.M.S. *Sirius.*

ble canvas hut, was put up. By early February, the settlement had taken shape. Phillip's house was on the eastern side of the cove. The marines were grouped around the Tank Stream (see **Tank Stream**). The convicts' tents were located mainly on the western side. On February 6, the women convicts were landed.

Phillip's commission was read on February 7, and the colony was proclaimed. On February 13, Phillip sent Philip Gidley King with a small party of marines and convicts to occupy Norfolk Island. A European settlement had been established in Australia, but its hold on the new country was far from strong.

**The colony's early years.** Phillip's major task was to make sure the colony would survive. It was an extremely difficult job. Buildings had to be erected, crops planted, and discipline maintained.

As governor, Phillip was, in effect, the government of the colony. He performed administrative duties that ranged from writing reports for the home government to making appointments and ordering punishments for those convicted of committing offences. He only had the assistance of the convicts. Most convicts were city or town people with few of the skills needed to establish a new colony, and according to observers, most were also lazy. Phillip's job was made even more difficult by the inexperience of many of the officials and the refusal of the marines to undertake nonmilitary duties, such as supervising convicts at work.

The first problem Phillip faced was the supply of food. The colony had enough supplies to last about a year. By that time, the first crops were to have been harvested. But the first crops of wheat, rice, and barley, which were planted in Farm Cove, failed. Farm animals died or vanished into the bush. A particular blow was the loss of two bulls and five cows. Their offspring were found seven years later near Camden. By that time, the herd had increased in the wild to more than 60 animals.

Some native animals were killed for food, but the settlement relied mainly on the salt meat brought with the fleet. By late 1788, supplies were running low. Phillip sent the ship *Sirius* to the Cape of Good Hope to buy more food. He also introduced *rationing,* which limited the amount of food each person was given at each meal. It was typical of Phillip's administration that everyone, including Phillip, received the same ration.

Phillip was not prepared to wait for supplies coming from outside the colony. In late 1788, he led expeditions looking for land better suited for cultivation than that at Sydney Cove. He chose Rose Hill, near Parramatta, as the site for a government farm. The farm was established by mid-1789, and new crops were planted.

Severe food shortages continued throughout 1789, and rations were further reduced. The harvest at the end of 1789 was successful, but it did not produce enough grain. By early 1790, starvation threatened the colony. In April, Phillip sent the *Supply* to Batavia (now Jakarta) to buy food supplies. The arrival of the Second Fleet with its supply ships in June helped relieve the food shortage. With the return of the *Supply* in October, there was no longer a threat of starvation in the near future.

The food shortage had been so severe that theft of food was a crime that could be punished by death. In 1788, five men were hanged for theft of food. In 1789, eight men and one woman were hanged. Phillip also established a night watch in August 1789 to guard government supplies. It was manned by convicts known for their good behaviour after the marines refused to do the duty. Conditions improved slowly during 1791. By 1792, the colony was on the way to self-sufficiency in most basic food stuffs.

Ill health among the colonists was also a major problem facing the new governor. *Scurvy,* a disease caused by lack of the vitamins in fresh fruit and vegetables, had been contained during the voyage out from Britain by providing the convicts with fresh food. But scurvy struck soon after landing, as rationing reduced the quality of the diet. *Dysentery,* an illness affecting the bowels, was also a problem. A tent hospital was erected in the colony, but treatment of the sick was difficult because there was not enough medicine. The arrival of the Second and Third fleets made the situation worse. A large proportion of convicts were seriously ill on arrival.

Canvas tents remained the main means of shelter in the colony for its first two years. Phillip's attempts to

build better buildings were frustrated by a severe shortage of carpenters and other skilled builders. Stores had been built by mid-1788 to protect supplies. The first roughly made huts for the marine's officers had been finished by December. Temporary barracks were not completed until 1789. A *kiln* (an oven for baking bricks) completed in 1790 helped Phillip's building programme. But permanent barracks were not completed until 1794.

**Exploration.** Early exploratory expeditions undertaken by Phillip or under his orders had one basic aim: to find land that could grow crops. Phillip led the upriver expedition that found good agricultural land near Parramatta in 1788. In 1789, he explored the coast north of Port Jackson. He found the mouth of the Hawkesbury River in Broken Bay and named it Pitt Water.

**Convicts.** During Phillip's administration, 3,546 male and 766 female convicts were landed in New South Wales. A high proportion were sick or aged. Most were totally unsuited for the task of building a new colony.

Phillip's attitude toward the convicts was basically one of encouraging reform. He offered rewards for good behaviour. These rewards included lighter duties and less supervision, a free grant of land when the convict's sentence had expired, and, for some, the lessening of their sentence or a grant of pardon. Phillip issued a total of 26 pardons. He also favoured *assignment*—that is, the provision of cheap convict labour to free settlers. But Phillip also insisted on strict discipline. Those convicted of offences were quickly and severely punished.

James Ruse provides an example of Phillip's attitude toward the convicts. Ruse claimed that his sentence had expired in 1789 and applied for a pardon and a grant of land. The records to confirm his story had not been sent from London, but Phillip allowed him to occupy an allotment of land at Rose Hill. If Ruse succeeded, Phillip promised him a farm of 12 hectares. Ruse was supplied with food, seed, farm tools, and farm animals to begin farming. He made a success of the venture, and by 1791, he was able to support himself and his wife on his farm. He received title to the land in April 1791. It was the first land grant to be made in New South Wales.

During his administration, Phillip used the convicts for public works projects. Many were employed in the construction of buildings and roads. From 1791, he used an increasing number as agricultural labourers on government farms at Rose Hill and Toongabbie. When the marines refused to act as overseers of convict labour or to serve in the night watch, Phillip assigned these duties to convicts who had behaved well.

**The marines.** Phillip's relationship with the marines was strained and often unhappy. The men were homesick, dissatisfied with their work, and frequently critical of the colony. The problems stemmed mainly from their commander, Major Robert Ross. He refused to allow the marines to take on duties beyond guarding convicts. For example, marines refused to supervise convict labour or to act as a night watch in 1789. Ross also refused to allow marines to serve on the criminal court, though several officers volunteered to do so. Ross felt that the officers should receive land grants. Phillip would only agree to do so if the officers left the corps. Ross was transferred to Norfolk Island in 1790, and the marines were replaced by the New South Wales Corps in 1791.

**Aborigines.** Phillip genuinely tried to become friendly with the Aborigines. It was not a policy supported by many of those under his command. Relations had already begun to sour by April 1788. On May 30, two rushcutters were killed and mutilated by Aborigines in a bay in Port Jackson. Rushcutters Bay got its name because of this incident. The Aborigines used hit-and-run tactics against the European settlers. The Europeans then mounted expeditions to punish them. The Europeans' superior weapons gave them a great advantage. In 1789, an outbreak of smallpox killed many Aborigines. This weakened them even further, so that they were no match for the Europeans.

Phillip found it difficult to make contact with the Aborigines. He felt that he needed an interpreter to act as a go-between. In December 1788, he captured an Aborigine named Arabanoo. Phillip wanted to show Arabanoo, and through him show the rest of the Aboriginal clans in the Sydney region, that the Europeans were peaceful. Arabanoo was disgusted by European forms of punishment. But he remained in the settlement until his death from smallpox in April 1789. In November 1789, two more Aborigines were captured, Colebee and Bennelong. Colebee escaped but Bennelong remained in Sydney until May 1790, when he, too, escaped.

In September 1790, Phillip received a report that a large group of Aborigines was gathered at Manly Cove. Bennelong was amongst them. Phillip armed a party to go to Manly. He hoped to convince Bennelong to return with him. During discussions with the Aborigines, Phillip threw away a dagger he was carrying, to show that the party was peaceful. The action was misunderstood and the governor was speared. The spear, with a four-metre shaft, passed through the collarbone area. Phillip's party retreated. The spear shaft was broken off, but people held grave fears for the governor's life. However, the wound was not as serious as first feared, and Phillip soon recovered. Some weeks after the incident, Bennelong returned to the settlement with another Aborigine, Yemmerrawannie. The two accompanied Phillip back to England in 1792.

**Phillip's policies** were shaped by both immediate problems and a long-term vision of what the colony of New South Wales could become. To convict administration, he brought a belief in the need for reform, which was expressed in his system of rewards for good behaviour. His method of discipline was firm, even harsh by today's standards. But generally, the convicts responded well to his administration. Phillip hoped to establish good relations with the Aborigines, though the policy failed. He encouraged the development of agriculture and the building of Sydney.

Phillip also saw much more in the future of New South Wales. Although few would have shared his view, he saw the colony as a new outpost of the British Empire. He saw the transportation of convicts as only one purpose for the colony. He also actively encouraged free immigrants to come to New South Wales. He believed free immigrants would be beneficial for society, would help with convict administration, and would establish a sound economy in the colony. To encourage their migration, he proposed free land grants of between 200 and 400 hectares with the promise of free convict labour for two years.

Phillip was a capable and efficient administrator. He steered the new settlement through its most difficult years. When he left, the population of New South Wales had grown to about 6,000 people. Free settlers were about to arrive in the colony and his land grant and convict assignment proposals had received official approval.

**Later life.** In 1794, Phillip married his second wife, Isabella, and settled in the city of Bath, in England. Phillip returned to the navy in 1796 as captain of the *Alexander.* He reached the rank of admiral a few weeks before his death. He was buried in the church of St. Nicholas, in the village of Bathampton, near Bath. A memorial to him was placed in Bath Abbey.

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**Phillip Island,** a popular Australian tourist centre, lies at the entrance to Western Port Bay, about 122 kilometres by road from Melbourne. Its Bass Strait coast has rugged cliffs and surf beaches. The northern coast is made up of sheltered beaches and mangrove swamps. Western Port Bay was discovered by George Bass in 1798. Phillip Island was used by early sealers and whalers. The island was leased to the McHaffie brothers in 1842. Extensive settlement began in the 1860's.

**Phillips, Wendell** (1811-1884), an American orator and reformer, became famous as an advocate of the abolition of slavery (see **Abolition movement**). He gave up his law practice in 1837 to join William Lloyd Garrison's group of abolitionists. Phillips fought against any individual, institution, or law that he thought prevented abolition. He favoured ending slavery even at the cost of breaking up the American Union. Phillips severely criticized the Administration of President Abraham Lincoln during the American Civil War (1861-1865).

After the war, Phillips held together the American Anti-Slavery Society until the passage of the 15th Amendment to the U.S. Constitution. This amendment made it illegal to deny the right to vote on the basis of race. Phillips also became interested in improving conditions for labourers. Many people who disagreed with Phillips admired his oratory. Phillips was born in Boston.

**Philodendron** is the name of many species and varieties of vinelike plants native to South America. The word *philodendron* means *lover of trees.* Many philodendrons are grown as house plants on posts made of sphagnum moss, bark, and other materials. The plants produce roots along their stems and will grow on poles if the stems are kept moist.

Philodendrons have handsome leaves that are thick and tough. But the leaves vary widely in size and shape on the different species of plants. The common name for some of these plants often suggests the form of their leaves. Among them are the *taper-tip, twice-cut, giant-leaf,* and *tri-leaf* philodendron.

Perhaps the most widely grown is the *heart-leaf* philodendron. This plant bears heart-shaped leaves about 2.5 to 5 centimetres long, and nearly as broad. The leaves of the heart-leaf philodendron are smooth and glossy. They have no indentations along their edges.

People like philodendrons as house plants because

**Philodendrons** are popular house plants. They are fast-growing climbing plants grown for their attractive foliage.

they are probably the easiest of all plants to grow. Philodendrons tolerate the changes in light, moisture, and temperature that are common in most houses. They need little care and do not fall prey to the usual plant pests. They grow best when they are not in direct sunlight. Often philodendrons will grow quite well in places that are too dark for other plants. Philodendrons can be grown in almost any kind of soil. They need to be kept moist throughout the year.

**Scientific classification.** Philodendrons belong to the arum family, Araceae. The heart-leaf philodendron is *Philodendron scandens.*

**Philology.** See **Linguistics.**

**Philosopher's stone.** See **Alchemy.**

**Philosophes** were a group of French philosophers during the Age of Reason, a historical period that extended from the late 1600's to the late 1700's. The group included such great philosophers as the Marquis de Condorcet, Denis Diderot, Claude Helvétius, Jean Jacques Rousseau, and Voltaire.

Generally, the philosophes believed in the ideal of progress. They wished to apply science's emphasis on reason to the study of people's moral and social life. The philosophes believed that knowledge could be acquired through experience. They wanted to separate moral doctrines from philosophical and religious considerations, because they believed that moral problems could be solved independently. The philosophes were generally anti-Christian, claiming that Christianity was basically unreasonable and filled with superstition. Generally, they opposed the political system in France and argued for reforms. Thus, they became forerunners of, and in some cases participants in, the French Revolution (1789-1799). See **French Revolution.**

See also **Age of Reason.**

**Philosophy** is a study that seeks to understand the mysteries of existence and reality. It tries to discover the nature of truth and knowledge and to find what is of basic value and importance in life. It also examines the relationships between humanity and nature and between the individual and society. Philosophy arises out of wonder, curiosity, and the desire to know and understand. Philosophy is thus a form of inquiry—a process involving analysis, criticism, interpretation, and speculation.

The term *philosophy* cannot be defined precisely because the subject is so complex and so controversial. Different philosophers have different views of the nature, methods, and range of philosophy. The term *philosophy* itself comes from the Greek *philosophia,* which means *love of wisdom.* In that sense, wisdom is the active use of intelligence, not something passive that a person simply possesses.

The first known Western philosophers lived in the ancient Greek world during the early 500's B.C. These early philosophers tried to discover the basic makeup of things and the nature of the world and of reality. For answers to questions about such subjects, people had largely relied on magic, superstition, religion, tradition, or authority. But the Greek philosophers considered those sources of knowledge unreliable. Instead, they sought answers to the questions by thinking and by studying nature.

Philosophy has also had a long history in some non-Western cultures, especially in China and India. But until about 200 years ago, there was little interchange between those philosophies and Western philosophy. This lack of contact between East and West existed chiefly because of difficulties of travel and communication. As a result, Western philosophy generally developed independently of Eastern philosophy.

## The importance of philosophy

Philosophic thought is an inescapable part of human existence. Almost everyone has been puzzled from time to time by such essentially philosophic questions as "What does life mean?" "Did I have any existence before I was born?" and "Is there life after death?" Most people also have some kind of philosophy in the sense of a personal outlook on life. Even a person who claims that considering philosophic questions is a waste of time is nevertheless expressing what is important, worthwhile, or valuable. Even a rejection of all philosophy is in itself philosophy.

By studying philosophy, people can clarify what they believe, and they can be stimulated to think about ultimate questions. A person can study philosophers of the past to discover why they thought as they did and what value their thoughts may have in one's own life. There are many people who simply enjoy reading the great philosophers, especially those who were also great writers.

Philosophy has had enormous influence on our everyday lives. The very language we speak uses classifications derived from philosophy. For example, the classifications of noun and verb involve the philosophic idea that there is a difference between things and actions. If we ask what the difference is, we are starting a philosophic inquiry.

Every institution of society is based on philosophic ideas, whether that institution is the law, government, religion, the family, marriage, industry, business, or education. Philosophic differences have led to the overthrow of governments, drastic changes in laws, and the transformation of entire economic systems. Such changes have occurred because the people involved held certain beliefs about what is important, true, real, and significant and about how life should be ordered.

Systems of education follow a society's philosophic ideas about what children should be taught and for what purposes. Democratic societies stress that people learn to think and make choices for themselves. Nondemocratic societies discourage such activities and want their citizens to surrender their own interests to those of the state. The values and skills taught by the educational system of a society thus reflect the society's philosophic ideas of what is important.

## The branches of philosophy

Philosophic inquiry can be made into any subject because philosophy deals with everything in the world and all of knowledge. But traditionally, and for purposes of study, philosophy is divided into five branches, each organized around certain distinctive questions. The branches are (1) metaphysics, (2) epistemology, (3) logic, (4) ethics, and (5) aesthetics. In addition, the philosophy of language has become so important during the 1900's that it is often considered another branch of philosophy.

**Metaphysics** is the study of the fundamental nature of reality and existence and of the essences of things. Metaphysics is itself often divided into two areas—*ontology* and *cosmology.* Ontology is the study of being. Cosmology is the study of the physical universe, or the cosmos, taken as a whole. Cosmology is also the name of the branch of science that studies the organization, history, and future of the universe.

Metaphysics deals with such questions as "What is real?" "What is the distinction between appearance and reality?" "What are the most general principles and concepts by which our experiences can be interpreted and understood?" and "Do we possess free will or are our actions determined by causes over which we have no control?"

Philosophers have developed a number of theories in metaphysics. These theories include *materialism, idealism, mechanism,* and *teleology.* Materialism maintains that only matter has real existence and that feelings, thoughts, and other mental phenomena are produced by the activity of matter. Idealism states that every material thing is an idea or a form of an idea. In idealism, mental phenomena are what is fundamentally important and real. Mechanism maintains that all happenings result from purely mechanical forces, not from purpose, and that it makes no sense to speak of the universe itself as having a purpose. Teleology, on the other hand, states that the universe and everything in it exists and occurs for some purpose.

**Epistemology** aims to determine the nature, basis, and extent of knowledge. It explores the various ways of knowing, the nature of truth, and the relationships between knowledge and belief. Epistemology asks such questions as "What are the features of genuine knowledge as distinct from what appears to be knowledge?"

"What is truth, and how can we know what is true and what is false?" and "Are there different kinds of knowledge, with different grounds and characteristics?"

Philosophers often distinguish between two kinds of knowledge, *a priori* and *empirical*. We arrive at a priori knowledge by thinking, without independent appeal to experience. For example, we know that there are 60 seconds in a minute by learning the meanings of the terms. In the same way, we know that there are 60 minutes in an hour. From these facts, we can deduce that there are 3,600 seconds in an hour, and we arrive at this conclusion by the operation of thought alone. We acquire empirical knowledge from observation and experience. For example, we know from observation how many keys are on a typewriter and from experience which key will print what letter.

The nature of truth has baffled people since ancient times, partly because people so often use the term *true* for ideas they find congenial and want to believe, and also because people so often disagree about which ideas are true. Philosophers have attempted to define *criteria* (standards of judgment) for distinguishing between truth and error. But they disagree about what truth means and how to arrive at true ideas. The *correspondence theory* holds that an idea is true if it corresponds to the facts or reality. The *pragmatic theory* maintains that an idea is true if it works or settles the problem it deals with. The *coherence theory* states that truth is a matter of degree and that an idea is true to the extent to which it *coheres* (fits together) with other ideas that one holds. *Scepticism* claims that knowledge is impossible to attain and that truth is unknowable.

**Logic** is the study of the principles and methods of reasoning. It explores how we distinguish between good (or sound) reasoning and bad (or unsound) reasoning. An instance of reasoning is called an *argument* or an *inference*. An argument consists of a set of statements called *premises* together with a statement called the *conclusion*, which is supposed to be supported by or derived from the premises. A good argument provides support for its conclusion, and a bad argument does not. Two basic types of reasoning are called *deductive* and *inductive*.

A good deductive argument is said to be *valid*—that is, the conclusion necessarily follows from the premises. A deductive argument whose conclusion does not follow necessarily from the premises is said to be *invalid*. The argument "All human beings are mortal, all Greeks are human beings, therefore all Greeks are mortal" is a valid deductive argument. But the argument "All human beings are mortal, all Greeks are mortal, therefore all Greeks are human beings" is invalid, even though the conclusion is true. On that line of reasoning, one could argue that all dogs, which are also mortal, are human beings.

Deductive reasoning is used to explore the necessary consequences of certain assumptions. Inductive reasoning is used to establish matters of fact and the laws of nature and does not aim at being deductively valid. One who reasons that all squirrels like nuts, on the basis that all squirrels so far observed like nuts, is reasoning inductively. The conclusion could be false, even though the premise is true. Nevertheless, the premise provides considerable support for the conclusion.

**Ethics** concerns human conduct, character, and values. It studies the nature of right and wrong and the distinction between good and evil. Ethics explores the nature of justice and of a just society, and also one's obligations to oneself, to others, and to society.

Ethics asks such questions as "What makes right actions right and wrong actions wrong?" "What is good and what is bad?" and "What are the proper values of life?" Problems arise in ethics because we often have difficulty knowing exactly what is the right thing to do. In many cases, our obligations conflict or are vague. In addition, people often disagree about whether a particular action or principle is morally right or wrong.

A view called *relativism* maintains that what is right or wrong depends on the particular culture concerned. What is right in one society may be wrong in another,

### Terms used in philosophy

**Aesthetics** is the branch of philosophy that studies art and beauty.

**Cosmology** is the study of the physical universe.

**Determinism** is the doctrine that all events have causes and occur by necessity.

**Dialectic** in the philosophy of G. W. F. Hegel is a process of change brought about by the conflict of opposites. This conflict creates a new unity, called a *synthesis*. The synthesis, in turn, comes into conflict with its opposite.

**Empiricism** is the view that experience is the source and test of knowledge.

**Epicureanism** is the belief that pleasure should be the goal of human activity but that true pleasure depends on self-control, moderation, and honourable behaviour.

**Epistemology** is the branch of philosophy that studies the nature, basis, and extent of knowledge.

**Ethics** is the branch of philosophy that studies human conduct and the nature of right and wrong.

**Hedonism** is the belief that the pleasure is the highest good.

**Humanism** is a philosophy that stresses the importance of human beings and their nature and place in the universe.

**Idealism** is the belief that fundamental reality is made up of minds and ideas, not of material objects. Idealists believe that the existence of objects depends on minds and ideas.

**Logic** is the branch of philosophy that deals with the principles of reasoning.

**Materialism** is a belief that only matter has real existence and that mental phenomena are produced by the activity of matter.

**Metaphysics** is the branch of philosophy that seeks to understand the nature of being and reality.

**Pragmatism** is a philosophy that tests the truth and value of ideas by their practical consequences.

**Rationalism** is the theory that knowledge can be derived from reason by itself, independent of the senses.

**Realism** is the doctrine that things exist in and of themselves, independent of ideas that people may have about them.

**Scepticism** is a philosophy that claims we can never have real knowledge of anything.

**Utilitarianism** is the belief that human conduct should be based on what produces the greatest good for the greatest number of people.

this view argues, and so no basic standards exist by which a culture may be judged right or wrong. *Objectivism* claims that there are objective standards of right and wrong which can be discovered and which apply to everyone. *Subjectivism* states that all moral standards are subjective matters of taste or opinion.

**Aesthetics** deals with the creation and principles of art and beauty. It also studies our thoughts, feelings, and attitudes when we see, hear, or read something beautiful. Something beautiful may be a work of art, such as a painting, symphony, or poem, or it may be a sunset or other natural phenomenon. In addition, aesthetics investigates the experience of engaging in such activities as painting, dancing, acting, and playing.

Aesthetics is sometimes identified with the philosophy of art, which deals with the nature of art, the process of artistic creation, the nature of the aesthetic experience, and the principles of criticism. But aesthetics has wider application. It involves both works of art created by human beings and the beauty found in nature.

Aesthetics relates to ethics and political philosophy when we ask questions about what role art and beauty should play in society and in the life of the individual. Such questions include "How can people's taste in the arts be improved?" "How should the arts be taught in the schools?" and "Do governments have the right to restrict artistic expression?"

**The philosophy of language** has become especially important in recent times. Some philosophers claim that all philosophic questions arise out of linguistic problems. Others claim that all philosophic questions are really questions about language. One key question is "What is language?" But there are also questions about the relationships between language and thought and between language and the world, as well as questions about the nature of meaning and of definition.

The question has been raised whether there can be a logically perfect language that would reflect in its categories the essential characteristics of the world. This question raises questions about the adequacy of ordinary language as a philosophic tool. All such questions belong to the philosophy of language, which has essential connections with other branches of philosophy.

## Philosophy and other fields

One peculiarity of philosophy is that the question "What is philosophy?" is itself a question of philosophy. But the question "What is art?" is not a question of art. The question is philosophic. The same is true of such questions as "What is history?" and "What is law?" Each is a question of philosophy. Such questions are basic to the philosophy of education, the philosophy of history, the philosophy of law, and other "philosophy of" fields. Each of these fields attempts to determine the foundations, fundamental categories, and methods of a particular institution or area of study. A strong relationship therefore exists between philosophy and other fields of human activity. This relationship can be seen by examining two fields: (1) philosophy and science and (2) philosophy and religion.

**Philosophy and science.** Science studies natural phenomena and the phenomena of society. It does not study itself. When science does reflect on itself, it becomes the philosophy of science and examines a number of philosophic questions. These questions include "What is science?" "What is scientific method?" "Does scientific truth provide us with the truth about the universe and reality?" and "What is the value of science?"

Philosophy has given birth to several major fields of scientific study. Until the 1700's, no distinction was made between science and philosophy. For example, physics was called *natural philosophy*. Psychology was part of what was called *moral philosophy*. In the early 1800's, sociology and linguistics separated from philosophy and became distinct areas of study. Logic has always been considered a branch of philosophy. However, logic has now developed to the point where it is also a branch of mathematics, which is a basic science.

Philosophy and science differ in many respects. For example, science has attained definite and tested knowledge of many matters and has thus resolved disagreement about those matters. Philosophy has not. As a result, controversy has always been characteristic of philosophy. Science and philosophy do share one significant goal. Both seek to discover the truth—to answer questions, solve problems, and satisfy curiosity. In the process, both science and philosophy provoke further questions and problems, with each solution bringing more questions and problems.

**Philosophy and religion.** Historically, philosophy originated in religious questions. These questions concerned the nature and purpose of life and death and the relationship of humanity to superhuman powers or a divine creator. Every society has some form of religion. Most people acquire their religion from their society as they acquire their language. Philosophy inquires into the essence of things, and inquiry into the essence of religion is a philosophic inquiry.

Religious ideas generated some of the earliest philosophic speculations about the nature of life and the universe. The speculations often centred on the idea of a supernatural or superpowerful being who created the universe and who governs it according to unchangeable laws and gives it purpose. Western philosophic tradition has paid much attention to the possibility of demonstrating the existence of God.

The chief goal of some philosophers is not understanding and knowledge. Instead, they try to help people endure the pain, anxiety, and suffering of earthly existence. Such philosophers attempt to make philosophic reflection on the nature and purpose of life perform the function of religion.

## Oriental philosophy

There are two main traditions in Oriental philosophy, Chinese and Indian. Both philosophies are basically religious and ethical in origin and character. They are removed from any interest in science.

Traditionally, Chinese philosophy has been largely practical, humanistic, and social in its aims. It developed as a means of bringing about improvements in society and politics. Traditionally, philosophy in India has been chiefly mystical rather than political. It has been dominated by reliance on certain sacred texts, called Vedas, which are considered inspired and true and therefore subject only for commentary and not for criticism. Much of Indian philosophy has emphasized withdrawal from everyday life into the life of the spirit. Chinese philoso-

phy typically called for efforts to participate in the life of the state in order to improve worldly conditions.

Chinese philosophy as we know it started in the 500's B.C. with the philosopher Confucius. His philosophy, called Confucianism, was the official philosophy of China for centuries, though it was reinterpreted by different generations. Confucianism aimed to help people live better and more rewarding lives by discipline and by instruction in the proper goals of life. Candidates for government positions had to pass examinations on Confucian thought, and Confucianism formed the basis for government decisions. No other civilization has placed such emphasis on philosophy.

Other philosophic traditions in China were Taoism, Mohism, and realism. Beginning in the A.D. 1100's, a movement known as Neo-Confucianism incorporated elements of all these doctrines.

We do not know exactly when Indian philosophy began. In India, philosophic thought was intermingled with religion, and most Indian philosophic thought has been religious in character and aim. Philosophic commentaries on sacred texts emerge during the 500's B.C. The Indian word for these studies is *darshana,* which means *vision* or *seeing.* It corresponds to what the ancient Greeks called *philosophia.*

In India, as in China, people conceived of philosophy as a way of life, not as a mere intellectual activity. The main aim of Indian philosophy was freedom from the suffering and tension caused by the body and the senses and by attachment to worldly things. The main philosophies developed in India were Hinduism and Buddhism, which were also religions. Yet some Indian philosophers did develop a complex system of logic and carried on investigations in epistemology. Some Indian philosophic ideas have been influential in the West. One such idea is *reincarnation,* the belief that the human soul is successively reborn in new bodies.

### The history of Western philosophy

The history of Western philosophy is commonly divided into three periods—ancient, medieval, and modern. The period of ancient philosophy extended from about 600 B.C. to about the A.D. 400's. Medieval philosophy lasted from the 400's to the 1600's. Modern philosophy covers the period from the 1600's to the present.

**Ancient philosophy** was almost entirely Greek. The greatest philosophers of the ancient world were three Greeks of the 400's and 300's B.C.—Socrates, Plato, and Aristotle. Their philosophy influenced all later Western culture. Our ideas in the fields of metaphysics, science, logic, and ethics originated from their thought. A number of distinctive schools of philosophy also flourished in ancient Greece.

***The pre-Socratics*** were the first Greek philosophers. Their name comes from the fact that most of them lived before the birth of Socrates, which was about 469 B.C. The pre-Socratic philosophers were mainly interested in the nature and source of the universe and the nature of reality. They wanted to identify the fundamental substance that they thought underlay all phenomena, and in terms of which all phenomena could be explained.

Unlike most other people of their time, the pre-Socratic philosophers did not believe that gods or supernatural forces caused natural events. Instead, they sought a natural explanation for natural phenomena. The philosophers saw the universe as a set of connected and unified phenomena for which thought could find an explanation. They gave many different and conflicting answers to basic philosophic questions. However, the importance of the pre-Socratics lies not in the truth of their answers but in the fact that they examined the questions in the first place. They had no philosophic tradition to work from, but their ideas provided a tradition for all later philosophers.

***Socrates*** left no writings, though he was constantly engaged in philosophic discussion. Our knowledge of his ideas and methods comes mainly from dialogues written by his pupil Plato. In most of the dialogues, Socrates appears as the main character, who leads and develops the process of inquiry.

Socrates lived in Athens and taught in the streets, market place, and gymnasiums. He taught by a question-and-answer method. Socrates tried to get a definition or precise view of some abstract idea, such as knowledge, virtue, justice, or wisdom. He would use close, sharp questioning, constantly asking "What do you mean?" and "How do you know?" This procedure, called the *Socratic method,* became the model for philosophic methods that emphasize debate and discussion.

Socrates wanted to replace vague opinions with clear ideas. He often questioned important Athenians and exposed their empty claims to knowledge and wisdom. This practice made him many enemies, and he was put to death as a danger to the state. He thus became a symbol of the philosopher who pursued an argument wherever it led to arrive at the truth, no matter what the cost.

***Plato*** believed that we cannot gain knowledge of things through our senses because the objects of sense perception are fleeting and constantly changing. Plato stated that we can have genuine knowledge only of changeless things, such as truth, beauty, and goodness, which are known by the mind. He called such things *ideas* or *forms.*

Plato taught that only ideas are real and that all other things only reflect ideas. This view became known as *idealism.* According to Plato, the most important idea is the idea of good. Knowledge of good is the object of all inquiry, a goal to which all other things are subordinate. Plato stated that the best life is one of contemplation of eternal truths. However, he believed people who have attained this state must return to the world of everyday life and use their skills and knowledge to serve humanity. Plato also believed that the soul is immortal and that only the body perishes at death. His ideas contributed to views about the body, soul, and eternal things later developed in Christian theology.

***Aristotle,*** Plato's greatest pupil, wrote about almost every known subject of his day. He invented the idea of a science and of separate sciences, each having distinct principles and dealing with different subject matter. He wrote on such topics as physics, astronomy, psychology, biology, physiology, and anatomy. Aristotle also investigated what he called "first philosophy," later known as *metaphysics.*

Aristotle created the earliest philosophic system. In his philosophy, all branches of inquiry and knowledge are parts of some overall system and connected by the same concepts and principles. Aristotle believed that all

things in nature have some purpose. According to his philosophy, the nature of each thing is determined by its purpose, and all things seek to fulfil their natures by carrying out these purposes.

Aristotle's basic method of inquiry consisted of starting from what we know or think we know and then asking how, what, and why. In his metaphysics, he developed the idea of a *first cause,* which was not itself caused by anything, as the ultimate explanation of existence. Christian theologians later adopted this idea as a basic argument for the existence of God. Aristotle taught that everyone aims at some good. He said that happiness does not lie in pleasure but in virtuous activity. By virtuous activity, he meant behaving according to a *mean* between extremes. For example, courage is the mean between the extremes of cowardice and foolhardiness. The highest happiness of all, Aristotle believed, was the contemplative use of the mind.

***Stoic philosophy and Epicureanism*** were the two main schools of Greek philosophy that emerged after the death of Aristotle in 322 B.C. Both schools taught that the purpose of knowing is to enable a person to lead the best and most contented life.

Stoic philosophy was founded by Zeno of Citium. He taught that people should spend their lives trying to cultivate virtue, the greatest good. The Stoics believed in strict *determinism*—the idea that all things are fated to be. Therefore, they said, a wise and virtuous person accepts and makes the best of what cannot be changed. Stoicism spread to Rome. There, the chief Stoics included the statesman Marcus Tullius Cicero, the emperor Marcus Aurelius, and the teacher Epictetus.

Epicureanism was founded by Epicurus. Epicurus based his philosophy on *hedonism*—the idea that the only good in life is pleasure. However, Epicurus taught that not all pleasures are good. The only good pleasures are calm and moderate ones because extreme pleasures could lead to pain. The highest pleasures, Epicurus said, are physical health and peace of mind, two kinds of freedom from pain.

***Scepticism*** was a school of philosophy founded by Pyrrho of Elis about the same time that Stoic philosophy and Epicureanism flourished. Pyrrho taught that we can know nothing. Our senses, he said, deceive us and provide no accurate knowledge of the way things are. Thus, all claims to knowledge are false. Because we can know nothing, in this view, we should treat all things with indifference and make no judgments.

***Neoplatonism*** was a revived version of some of Plato's ideas as adapted by Plotinus, a philosopher who may have been born in Egypt in the A.D. 200's. Neoplatonism tried to guide the individual toward a unity—a oneness—with God, which is a state of blessedness. Plotinus believed that the human soul yearns for reunion with God, which it can achieve only in mystical experience. Neoplatonism provided the bridge between Greek philosophy and early Christian philosophy. It inspired the idea that important truths can be learned only through faith and God's influence, not by reason.

**Medieval philosophy.** During the Middle Ages, Western philosophy developed more as a part of Christian theology than as an independent branch of inquiry. The philosophy of Greece and Rome survived only in its influence on religious thought.

Saint Augustine was the greatest philosopher of the early Middle Ages. In a book entitled *The City of God* (early 400's), Augustine interpreted human history as a conflict between faithful Christians living in the city of God and pagans and heretics living in the city of the world. Augustine wrote that the people of the city of God will gain eternal salvation, but the people in the city of the world will receive eternal punishment. The book weakened the belief in the pagan religion of Rome and helped further the spread of Christianity.

A system of thought called *scholasticism* dominated medieval philosophy from about the 1100's to the 1400's. The term *scholasticism* refers to the method of philosophic investigation used by teachers of philosophy and theology in the newly developing universities of western Europe. The teachers were called *scholastics.* The scholastic method consisted in precise analysis of concepts with subtle distinctions between different senses of these concepts. The scholastics used deductive reasoning from principles established by their method to provide solutions to problems.

Scholasticism was basically generated by the translation of Aristotle's works into Latin, the language of the medieval Christian church. These works presented medieval thinkers with the problem of reconciling Aristotle's great body of philosophic thought with the Bible and Christian doctrine. The most famous scholastic was Saint Thomas Aquinas. His philosophy combined Aristotle's thought with theology, and it eventually became the official philosophy of the Roman Catholic Church.

The great contributions of the scholastics to philosophy included major development of the philosophy of language. The scholastics studied how features of language can affect our understanding of the world. They also emphasized the importance of logic to philosophic inquiry.

**Modern philosophy.** A great cultural movement in Europe called the Renaissance overlapped the end of the Middle Ages and formed a transition between medieval and modern philosophy. The Renaissance began in Italy and lasted from about 1300 to about 1600. It was a time of intellectual reawakening stemming from the rediscovery of ancient Greek and Roman culture. During the Renaissance, major advances occurred in such sciences as astronomy, physics, and mathematics. Scholars called *humanists* stressed the importance of human beings and the study of classical literature as a guide to understanding life. Emphasis on science and on humanism led to changes in the aims and techniques of philosophic inquiry. Scholasticism declined, and philosophy was freed of its ties to medieval theology.

One of the earliest philosophers to support the scientific method was Francis Bacon of England. Most historians consider Bacon and René Descartes of France to be the founders of modern philosophy. Bacon wrote two influential works, *The Advancement of Learning* (1605) and *Novum Organum* (1620). He stated that knowledge was power and that knowledge could be obtained only by the inductive method of investigation. Bacon imagined a new world of culture and leisure that could be gained by inquiry into the laws and processes of nature. In describing this world, he anticipated the effects of advances in science, engineering, and technology.

***Rationalism*** was a philosophic outlook that arose in

the 1600's. The basic idea of rationalism is that reason is superior to experience as a source of knowledge and that the validity of sense perception must be proved from more certain principles. The rationalists tried to determine the nature of the world and of reality by deduction from premises themselves established as certain *a priori*. They also stressed the importance of mathematical procedures. The leading rationalists were René Descartes, Baruch Spinoza, and Gottfried Leibniz.

Descartes was a mathematician as well as a philosopher. He invented analytical geometry. Descartes's basic idea was to establish a secure foundation for the sciences, a foundation of the sort he had found for mathematics. He was thus much concerned with the foundations of knowledge, and he started philosophy on its persistent consideration of epistemological problems. Descartes was a *mechanist*—that is, he regarded all physical phenomena as connected mechanically by laws of cause and effect. Descartes's philosophy generated the problem of how mind and matter are related.

Spinoza constructed a system of philosophy on the model of geometry. He attempted to derive philosophic conclusions from a few central *axioms* (supposedly self-evident truths) and definitions. Spinoza did not view God as some superhuman being who created the universe. He identified God with the universe. Spinoza was also a mechanist, regarding everything in the universe as determined. Spinoza's main aim was ethical. He wanted to show how people could be free, could lead reasonable and thus satisfying lives, in a deterministic world.

Leibniz believed that the actual world is only one of many possible worlds. He tried to show how the actual world is the best of all possible worlds in an effort to justify the ways of God to humanity. Thus, he attempted to solve the problem of how a perfect and all-powerful God could have created a world filled with so much suffering and evil. Leibniz and Sir Isaac Newton, an English scientist, independently developed calculus. Leibniz' work in mathematics anticipated the development of *symbolic logic*—the use of mathematical symbols and operations to solve problems in logic.

***Empiricism*** emphasizes the importance of experience and sense perception as the source and basis of knowledge. The first great empiricist was John Locke of England in the 1600's. George Berkeley of Ireland and David Hume of Scotland further developed empiricism in the 1700's.

Locke tried to determine the origin, extent, and certainty of human knowledge in *An Essay Concerning Human Understanding* (1690). Locke argued that there are no *innate* ideas—that is, ideas people are born with. He believed that when a person is born, the mind is like a blank piece of paper. Experience is therefore the source of all ideas and all knowledge.

Berkeley dealt with the question "If whatever a human being knows is only an idea, how can one be sure that there is anything in the world corresponding to that idea?" Berkeley answered that "to be is to be perceived." No object exists, he said, unless it is perceived by some mind. Material objects are ideas in the mind and have no independent existence.

Hume extended the theories of Locke and Berkeley to a consistent scepticism about almost everything. He maintained that everything in the mind consists of impressions and ideas, with ideas coming from impressions. Every idea can be traced to and tested by some earlier impression. According to Hume, we must be able to determine from what impression we derived an idea for that idea to have meaning. An apparent idea that cannot be traced to an impression must be meaningless. Hume also raised the question of how can we know that the future will be like the past—that the laws of nature will continue to operate as they have. He claimed that we can only know that events have followed certain patterns in the past. We cannot therefore be certain that events will continue to follow those patterns.

***The Age of Reason*** was a period of great intellectual activity that began in the 1600's and lasted until the late 1700's. The period is also called the Enlightenment. Philosophers of the Age of Reason stressed the use of reason, as opposed to the reliance on authority and scriptural revelation. For them, reason provided means of attaining the truth about the world and of ordering human society to assure human well-being. The leading philosophers included Descartes, Locke, Berkeley, and Hume. They also included Jean Jacques Rousseau, Voltaire, Denis Diderot, and other members of a group of French philosophers called the *philosophes*.

Locke's philosophic ideas were characteristic of the Age of Reason. Locke sought to determine the limits of human understanding and to discover what can be known within those limits that will serve as a guide to life and conduct. He tried to show that people should live by the principles of toleration, liberty, and natural rights. His *Two Treatises of Government* (1690) provided the philosophic base for the American Revolution and the French Revolution in the late 1700's.

***The philosophy of Immanuel Kant,*** a great German philosopher of the late 1700's, became the foundation for nearly all later developments in philosophy. Kant's philosophy is called *critical philosophy* or *transcendental philosophy*. Kant was stimulated by the sceptical philosophy of Hume to try to bring about a synthesis of rationalism and empiricism. In his *Critique of Pure Reason* (1781), Kant tried to provide a critical account of the powers and limits of human reason, to determine what is knowable and what is unknowable. Kant concluded that reason can provide knowledge only of things as they appear to us, never of things as they are in themselves. Kant believed that the mind plays an active role in knowing and is not a mere recorder of facts presented by the senses. The mind does this through basic categories or forms of understanding, which are independent of experience and without which our experience would not make sense. Through such categories and the operations of the mind, working on sense experience, we can have knowledge, but only of things that can be experienced.

Kant criticized the traditional arguments for the existence of God. He argued that they are all in error because they make claims that go beyond the possibility of experience and thus go beyond the powers of human reason. In his *Critique of Practical Reason* (1788), Kant argued that *practical reason* (reason applied to practice) can show us how we ought to act and also provides a practical reason for believing in God, though not a proof that God exists.

***Philosophy in the 1800's.*** Kant's philosophy stimulated various systems of thought in the 1800's, such as those of G. W. F. Hegel and Karl Marx of Germany. Hegel developed a theory of historical change called *dialectic,* in which the conflict of opposites results in the creation of a new unity and then its opposite. Hegel's theory was transformed by Marx into *dialectical materialism.* Marx believed that only material things are real. He stated that all ideas are built on an economic base. He believed that the dialectic of conflict between capitalists and industrial workers will lead to the establishment of communism, which he called *socialism,* as an economic and political system.

Friedrich Nietzsche, a German philosopher, was an atheist who proclaimed in *Thus Spake Zarathustra* (1883-1885) that "God is dead." Nietzsche meant that the idea of God had lost the power to motivate and discipline large masses of people. He believed that people would have to look to some other idea to guide their lives. Nietzsche predicted the evolution of the *superman,* who would be beyond the weakness of human beings and beyond the merely human appeals to morality. He regarded such appeals as appeals to weakness, not strength. He felt that all behaviour is based on the *will to power*—the desire of people to control others and their own passions. The superman would develop a new kind of perfection and excellence through the capacity to realize the will to power through strength, rather than weakness.

The dominant philosophy in England during the 1800's was *utilitarianism,* developed by Jeremy Bentham and John Stuart Mill. The utilitarians maintained that the greatest happiness for the greatest number of people is the test of right and wrong. They argued that all existing social institutions, especially law and government, must be transformed to satisfy the test of greatest happiness. In *The Subjection of Women* (1869), Mill wrote that the legal subordination of women to men ought to be replaced by "a principle of perfect equality." That idea was revolutionary in Mill's time.

***Philosophy in the 1900's*** has seen five main movements predominate. Two of these movements, *existentialism* and *phenomenology,* have had their greatest influence in the countries on the mainland of western Europe. The three other movements, *pragmatism, logical positivism,* and *philosophical analysis,* have been influential chiefly in the United States and Britain.

Existentialism became influential in the mid-1900's. World War II (1939-1945) gave rise to widespread feelings of despair and of separation from the established order. These feelings led to the idea that people have to create their own values in a world in which traditional values no longer govern. Existentialism insists that choices have to be made arbitrarily by individuals, who thus create themselves, because there are no objective standards to determine choice. The most famous of the existentialist philosophers is the French author Jean-Paul Sartre.

Phenomenology was developed by the German philosopher Edmund Husserl. Husserl conceived the task of phenomenology, hence the task of philosophy, as describing phenomena—the objects of experience—accurately and independently of all assumptions derived from science. He thought that this activity would provide philosophic knowledge of reality.

Pragmatism, represented in the 1900's by William James and John Dewey of the United States, maintains knowledge is subordinate to action. The meaning and truth of ideas are determined by their relation to practice.

Logical positivism, developed in Vienna, Austria, in the 1920's, teaches that philosophy should analyse the logic of the language of science. It regards science as the only source of knowledge and claims metaphysics is meaningless. It bases this claim on the principle of *verifiability,* by which a statement is meaningful only if it can be verified by sense experience. One of the greatest logical positivists was the Briton Sir Alfred Jules Ayer.

Philosophical analysis generally tries to solve philosophic problems through analysis of language or concepts. Some versions of this philosophy attempt to show that traditional philosophic problems *dissolve*—that is, disappear—on proper analysis of the terms in which they are expressed. Other versions use linguistic analysis to throw light on, not dissolve, traditional philosophic problems. The most influential philosophers practising philosophic analysis have been Bertrand Russell of England and Ludwig Wittgenstein, who was born in Austria but studied and taught in England.

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**Outline**

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**Questions**

Who are considered the cofounders of modern philosophy?
How do mechanism and teleology differ?
Who were the scholastics?
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What is *a priori* knowledge? *Empirical* knowledge?
How did traditional Chinese and Indian philosophy differ?
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How do a society's philosophic ideas influence education?
In Friedrich Nietzsche's thought, who was the superman?
What is the *Socratic method*?

**Phlebitis** is an inflammation of a vein. It can develop in any part of the body, but it most commonly occurs in the legs. Phlebitis usually produces tenderness, swelling, redness, and pain in the area of the vein.

Phlebitis may lead to *thrombophlebitis*—that is, the formation of a blood clot along the lining of the inflamed vein. If the blood clot breaks loose and travels through the bloodstream, the clot may become stuck and create an *embolism* (blockage of a blood vessel). An embolism that occurs in the heart or lungs can be fatal (see **Embolism**).

Most cases of phlebitis are caused by an injury or by an infection of a vein. Phlebitis also may result from poor circulation in the veins due to prolonged bed rest, pregnancy, being overweight, heart failure, or other conditions.

In treating phlebitis of the legs, doctors advise elevation of the affected limb to reduce inflammation. The patient should wear an elastic support stocking when walking. In severe cases of phlebitis, bed rest is required to prevent clots from breaking loose. Drugs called *anticoagulants* may be prescribed to prevent clotting. In some cases, surgery may be necessary.

See also **Vein**.

**Phloem.** See **Bark** (with diagram); **Tree** (Trunk and branches; picture).

**Phlogiston theory.** See **Chemistry** (The phlogiston theory).

**Phlox** is a common garden plant with brilliantly coloured blossoms. The name *phlox* comes from the Greek word for *flame*. In spite of their range of colours, the phlox blossoms are never flame-coloured.

Phlox are native to North America. They are favourite garden flowers because they are hardy and grow well in fertile soil. All annual phlox are derived from a species that grows wild in Texas, U.S.A.

The flowers grow in clusters on the tops of stems which may be 60 to 90 centimetres high. Annual varieties of phlox are grown from seeds.

Perennial phlox are native to the eastern United States. They grow best in fertile, well-drained soil that retains some moisture.

**Scientific classification.** Phlox belongs to the phlox family, Polemoniaceae. Annual phlox is *Phlox drummondii*. A common species of perennial phlox is *P. paniculata*.

See also **Flower** (picture: Garden perennials).

**Phnom Penh** is the capital of Cambodia. It lies in the south-central part of the country, where the Tonle Sap and Bassac rivers join the Mekong River. For the location of Phnom Penh, see **Cambodia** (map). Phnom Penh serves as Cambodia's trading and industrial centre. It has distilleries, rice mills, and textile factories.

Phnom Penh was founded in the 1400's and became the permanent capital in 1867. In 1970, the Vietnam War between Communists and non-Communists spread to Cambodia. Communists called the Khmer Rouge gained control of the country in 1975. At that time, Phnom Penh had a population of about 2 million. The Khmer Rouge then moved most of the people out of the city to work in rural areas. The population fell to an estimated 20,000 people.

In 1979, other Communists and Vietnamese troops overthrew the Khmer Rouge and took control of Phnom Penh. People then began returning to the city, and the population had grown to an estimated 700,000 by the late 1980's.

**Phobia** is a persistent, unduly strong fear of a certain object or situation. Common phobias include fear of crowds, darkness, heights, and such animals as cats, snakes, or spiders. Phobias may severely limit a person's life. Phobic individuals may spend much time worrying about their fears and may be too frightened to carry out normal activities.

Many phobias have special names. For example, the fear of heights is called *acrophobia*. *Agoraphobia* is the

dread of open spaces, and *claustrophobia* is the fear of confined spaces or of being closed in. *Ailurophobia* is the fear of cats, *ophidiophobia* is the fear of snakes, and *arachnophobia* is the fear of spiders. Other phobias include *hydrophobia* (fear of water), *mysophobia* (fear of dirt or germs), and *xenophobia* (fear of foreigners or strangers).

Therapists use numerous approaches to treat phobias. Two popular treatments are *psychoanalysis* and *behavioural therapy,* which are based on different ideas about the causes of psychological problems.

Sigmund Freud, an Austrian doctor and the founder of psychoanalysis, believed that phobias and other psychological disorders are caused by unconscious desires. According to Freud, individuals *repress* (force into the unconscious mind) desires that they have been taught are bad. Freudians believe that a phobia is a symbolic expression of these repressed feelings, such as aggressive impulses or sexual drives, and of the punishment linked with the feelings in the unconscious. In psychoanalytic treatment of phobias, the therapist and patient try to uncover such repressed feelings. Psychoanalysts believe that when a patient fully understands the repressed feelings, the fear will disappear or become manageable.

Behavioural therapy is the method most often used to treat phobias. It holds that a phobia is a learned response and can be unlearned. Therapists using behavioural treatments often employ techniques that involve gradually exposing the phobic individual to whatever is feared. The exposure may take place in real life or in the person's imagination. For example, claustrophobic patients may imagine themselves in smaller and smaller rooms until they can visualize a tiny space without anxiety. The gradualness of the exposure is considered important in making the treatment effective and relatively painless. A popular technique called *systematic desensitization* combines gradual exposure with relaxation or other experiences to reduce anxiety.

Many therapists who treat phobias conduct group therapy in addition to individual treatment. Group therapy enables phobic patients to talk with others who have the same fears and learn from one another. Some therapists also use hypnosis to help phobic patients face their fears.

**Phobos.** See **Mars** (Satellites; picture).

**Phoebe** a small, active bird, native to North and South America, belongs to the flycatcher family. It has a greyish-olive back and a yellowish-white breast. The eastern phoebe is common throughout eastern North America in summer. The black phoebe is found in the southern United States southward to Argentina. The phoebe gets its name from its monotonous call, "fee-bee." It lives around farm buildings and bridges, where it plasters its nest to rafters and beams. It builds its nest from moss and mud, and lines it with grass and hair. The phoebe lays three to eight eggs. It eats insects.

**Scientific classification.** The phoebe is in the tyrant flycatcher family, Tyrannidae. The eastern phoebe is *Sayornis phoebe.* The black phoebe is S. nigricans.

**Phoenicia** was the name the ancient Greeks gave to the region that is now roughly the coastal areas of Syria, Lebanon, and Israel. The Eleutherus River formed the northern boundary and Mount Carmel the southern. This region lay between the Lebanon Mountains to the east and the Mediterranean Sea on the west.

The origin of the word *Phoenicia* is not certain. It appears to have developed from the word *Canaan,* meaning *land of purple,* the name first used for ancient Palestine and Syria. Canaan was an important source of red-purple dyed goods. The Greeks probably used their word *phoinix,* which meant *red-purple,* when referring to the people who traded these red-purple goods to them. *Phoinike,* or *Phoenicia,* eventually became the name of Canaan's coastal strip.

The Phoenicians were one of the most famous peoples of the ancient world. They were great sailors, navigators, and traders. They won distinction in history for two achievements. They were among the first to send out explorers and to establish colonies throughout the Mediterranean Sea area, and even beyond the Strait of Gibraltar.

The Greek alphabet developed from that of the Phoenicians, and the Roman and all Western alphabets have been taken from the Greek.

## Way of life

Phoenicians cannot be easily distinguished from other peoples who lived in Canaan before the Israelites settled there. For this reason, the Phoenicians are sometimes called *Canaanites* in the Old Testament. More often, they are called *Sidonians,* from the name of the Phoenician city of Sidon. Scholars now know that the northern Phoenician city of Ugarit (now Ras Shamra in western Syria) was in contact with the Cretan civilization as early as 1900 B.C. Between 1400 and 1200 B.C., a Mycenaean colony thrived at Ugarit.

**Language.** The Phoenicians spoke a dialect of the Semitic languages. The Phoenician language was closely related to Hebrew. It was more distantly related to Aramaic and to the Semitic languages of Mesopotamia, such as Assyrian and Babylonian. Scholars once believed that the Phoenicians had invented their alphabet independently. But later discoveries indicated that they had adapted it from earlier writing. The Phoenician alphabet consisted of 22 consonant signs. The Greeks added the vowel signs later.

By the beginning of the Christian Era, Aramaic had become the language of Phoenicia. But North Africans near the former Phoenician colony of Carthage continued to speak the Phoenician language until the A.D. 500's, using a dialect called *Punic.* Some names of places in southern Spain, colonized by the Phoenicians in the 700's B.C. or earlier, come from the Phoenician language. The name of *Gades* (now Cádiz, Spain) comes from the Phoenician word for *wall.* The word *bible* comes from


**Location of Phoenicia and its colonies**

the Greek word for *book*. The Greeks took this word from the Phoenician city of Byblos, a trading centre for papyrus.

A few fragments of Phoenician literature have survived in Greek translation. Since 1929, important discoveries have been made at the site of ancient Ugarit. Religious inscriptions on clay tablets found there clarify some formerly obscure passages in the Old Testament. The tablets were written in cuneiform, in an alphabetical style that differs from the standard Phoenician (see **Cuneiform**).

**Trade and manufacturing.** The Phoenicians were seagoing traders from the very beginning of their recorded history. The Egyptians knew about the "ships of Gebal" (Byblos) as early as 2900 B.C. But Phoenicia did not reach its peak as a great sea power until about 1000 B.C. and after.

The city of Sidon grew famous for its purple dye, and developed a well-known glass industry. Tyre also had a purple-dyeing industry, and became noted for the bad odour that the dye works caused. Phoenicia was one of the garden spots of the Roman Empire, and exported wine, oil, and laurel and cedar wood, as well as textiles and other manufactured goods.

The Phoenicians learned most of their methods of manufacturing from the Egyptians. They cast, hammered, and engraved metals, such as gold and silver. They carved many objects from ivory, including pieces of furniture. From early times, Phoenicians knew how to weave woollen and linen cloth. The craftworkers dyed the cloth and often sewed it into robes before they sold it. The Greeks later adopted the *keton*, a Phoenician shirtlike garment.

**Religion.** Phoenicians had many gods and goddesses called *baal* (lord) and *baalat* (lady). All Phoenicians worshipped the same major gods, although these gods sometimes were known by different names in different cities. For example, Melqart, god of Tyre, could also be thought of as the *Baal* of Tyre. The Phoenicians practised sacrifices similar to those practised by most other Semitic peoples. But they also offered human sacrifices in Phoenicia and in their colonies, which gained for them a reputation for cruelty.

The story of Astarte and her lover Adonis, well-known in Phoenicia, was carried from there to Greece, where Astarte became the Greek goddess Aphrodite. The Romans later knew her as Venus. The tragic death of her lover by the tusks of a wild boar and her lament for him comes down to us through Greek, Latin, and English literature in the story of Venus and Adonis.

**Government.** The ancient Phoenicians lived in a number of independent city-states. Like the Greeks, they never united their cities into a single country. These cities originally were aristocracies ruled by kings. Beginning in the 800's B.C., councils of elders ruled with the kings, and some of the councils were more powerful than the kings. Later, most cities were ruled by government officials called *shofets*. Most of the Phoenician mountains came down to the sea, and the ancient towns were originally built on islands, like Tyre and Arvad, or occupied a small harbour area on the mainland with hills to the back of it. The most important of these coastal cities, from north to south, were Arvad, Byblos, Berytus (now Beirut), Sidon, Tyre, and Acco. Beirut, the present-day capital and chief seaport of Lebanon, is the only city that is still important.

## History

**Foreign control.** Phoenicia was a natural meeting place for foreign cultures, because it lay on the main avenue of traffic between Egypt to the south and Asia Minor and Mesopotamia to the east. Egypt exerted the earliest influence on the Phoenicians. As early as the time of the Old Kingdom, from about 2686 to 2181 B.C., Egypt was importing the famed cedars of Lebanon. By the time of the Middle Kingdom, from about 2052 to 1786 B.C., the two countries had established regular trade. The Phoenicians exported timber and pitch, and imported gold and manufactured articles. In the 1400's B.C., Phoenicia became a frontier province of Egypt, and remained one for about 100 years. During this period, the Phoenician cities influenced Egypt almost as much as Egypt influenced them. Phoenician nobles often visited the Egyptian court. Phoenician cults and religious ideas affected Egyptian thought.

Babylonian culture also influenced early Phoenicia. By the 1300's B.C., the princes of Phoenicia were writing in Babylonian cuneiform (see **Cuneiform**). The Phoenicians learned to seal their documents with Babylonian cylinders and seals. The Babylonians also taught the Phoenicians many of their mythological tales about the beginning of the world, the birth of the gods, and the creation of human beings. Some scholars believe that Phoenicia may have been the channel through which the Babylonian legends about the creation and the flood passed to the Hebrews farther south and to the Greeks.

For a short period in the 1200's B.C., Phoenicia came under the Hittite sphere of influence, but gained its freedom when the Hittite Empire collapsed.

**The spread of Phoenician influence.** The Phoenician cities gained their independence about 1100 B.C. For the next 250 years, they stood at the height of their power and prosperity. There were Phoenician settlements on the island of Cyprus even before the 1100's B.C. After that date, Phoenician sailors opened up the entire Mediterranean to their ships and commerce. They established colonies along the southern coast of Spain, the northern coast of Africa, and the western coast of Sicily. It may be said that the western Mediterranean was a "Phoenician lake" before the coming of the Greeks.

Phoenicians influenced Western culture through their colony of Carthage. This greatest of all Phoenician colonies in the West was founded by people from the city of Tyre about 750 B.C. Queen Dido was one of the legendary founders of Carthage (see **Dido**). Phoenician colonies, including Carthage, resembled the cities of Phoenicia. Many manufacturers, industrial workers, merchants, and sailors lived there.

The city of Tyre seems to have played the main part in the colonizing activity of the Phoenicians. A vivid description of Tyre's far-flung commerce appears in the Old Testament (Ezekiel 27: 3-25). When King David of Israel established his royal residence at Jerusalem, he built his palace with stone and cedars from Lebanon (II Samuel 5: 11). The first book of Kings tells that Hiram, king of Tyre in the 900's B.C., was a friend of David's successor, King Solomon. When Solomon built his famous

Temple, he asked Hiram for firs and cedars from Lebanon, and for men to cut the timber. When Solomon built a navy, Hiram lent him certain workers who were "shipmen that had knowledge of the sea" (I Kings 9: 27). The base of this fleet was the Red Sea port of Ezion-Geber on the Gulf of Aqaba. This site, recently excavated, contains the remains of a once great smelting and mining centre. Hiram and Solomon combined to send from this port great fleets of merchant vessels, which came back loaded with "gold and silver, ivory and apes and peacocks" (II Chronicles 9: 21). In return, Solomon traded grain, olive oil, wine, and other agricultural products with Hiram.

Some scholars believe that Phoenician influence and perhaps Phoenician colonists reached Corinth and Thebes on the mainland of Greece. This tradition of Phoenician colonization in Greece may be exaggerated. But the Phoenicians appear in the poems of Homer as skilled artisans, merchants, and sailors. The Phoenician alphabet also reached Greece soon after 800 B.C.

Control of both sides of the Strait of Gibraltar gave the Phoenicians access to the Atlantic Ocean. They established a trading monopoly along the coasts of northwestern Africa and western Europe. Some scholars believe that the Phoenicians may have sailed as far as Cornwall, in southwestern Britain, and worked the tin mines there. Phoenicians sailed around Africa in the 600's B.C., some 2,000 years before the Portuguese accomplished the same feat in A.D. 1497. The Greek historian Herodotus tells this story in the fourth book of his *History.*

**Decline.** The Assyrians captured the Phoenician cities in 842 B.C. For the next 200 years, Phoenicia was controlled by Assyria. This period was one of hardship, revolt, and suppression. After the downfall of the Assyrians in 612 B.C., Phoenicia was briefly controlled by the Babylonians. Later, the region became part of the Persian Empire created by King Cyrus I (see **Cyrus the Great**). At this time, the city of Sidon seems to have surpassed Tyre in importance. Under Persian rule, Phoenician cities prospered and the Phoenicians were still considered excellent shipbuilders and sailors. During the Persian Wars, (490-479 B.C.), the Phoenician fleet ranked as the strongest arm of the Persian Navy in its attack upon Greece. Herodotus says that in this fleet the king of Sidon ranked second to Xerxes, the Persian ruler (see **Xerxes I**). But the Phoenician fleet was almost completely destroyed by the Greeks at the Battle of Salamis in 480 B.C.

Phoenicia came under Greco-Macedonian rule when Alexander the Great captured the city of Tyre in 332 B.C. His successors, the rulers of Egypt and Syria, fought among themselves for possession of the Phoenician cities and for control of their shipbuilding and commercial resources. During this period, the culture of Phoenicia changed. Greek gradually became the language of literature and learning. Aramaic, which had earlier replaced the Phoenician language, became the language of the marketplace and of the common people. Many philosophers of the time, including Zeno of Sidon and Diodorus of Tyre, were of Phoenician origin.

In 64 B.C., the Roman general Pompey the Great made Phoenicia part of the Roman province of Syria. The Romans established a famous law school at Beirut. Tyre and Sidon became important centres of learning, and continued to prosper commercially. Tyre became known for the manufacture of fine glass. Phoenicia, together with the rest of Syria, fell to Muslim invaders in the A.D. 600's.

**Related articles** in *World Book* include:

Cities

| | |
|---|---|
| Carthage | Tyre |
| Sidon | Utica |

Other related articles

| | |
|---|---|
| Alphabet | Canaanites |
| Astarte | Ship (Phoenician and Greek ships) |
| Baal | |

**Phoenix** (pop. 983,403; met. area pop. 2,112,101) is the capital and largest city of Arizona. It is a major resort centre and is also known for the manufacture of computers and electronic equipment. The city lies in the Salt River Valley, a flat region ringed by low mountains. Phoenix was founded in 1870.

Phoenix is one of the fastest growing cities in the United States. Its chief manufactured products include computers, electronic equipment, chemicals, fertilizers, military weapons, and processed foods. Tourism earns Phoenix about 1.8 billion U.S. dollars a year.

**Phoenix** was a fabled bird in Greek mythology. Only one such bird existed at any time, and it was always male. It had brilliant gold and reddish-purple feathers, and was as large or larger than an eagle. According to some Greek writers, the phoenix lived exactly 500 years. Other writers believed its life cycle was as long as 12,954 years.

At the end of each life cycle, the phoenix burned itself on a funeral pyre. Another phoenix then rose from the ashes with renewed youth and beauty. The young phoenix, after rising from the ashes, carried the remains of its father to the altar of the sun god in the Egyptian city of *Heliopolis* (City of the Sun). The long life of the phoenix, and its dramatic rebirth from its own ashes, made it a symbol of immortality and spiritual rebirth.

The Greeks probably took their idea of the phoenix from the Egyptians, who worshipped the *bennu*, a sacred bird similar to the stork. The bennu, like the phoenix, was connected with the sun worship rites in Heliopolis. Both birds represented the sun, which dies in its flames each evening and emerges each morning.

**Phon** is a unit of the level of loudness of sound as perceived by a listener. The loudness level of a sound in phons is equal to the sound pressure level in decibels of another sound that has a frequency of 1,000 hertz (vibrations per second) and sounds equally loud to the listener. For example, any sound that seems as loud as a 60-decibel sound of 1,000 hertz has a loudness level of 60 phons. The loudness level of sound cannot be measured with a meter because it is based on the judgment of a listener. However, charts may be used to estimate loudness levels at different sound pressures and frequencies.

See also **Decibel; Sound** (Measuring sound).

**Phonetics** is the science of speech sounds, and the symbols by which they are shown in writing and printing. This science is based on a study of all the parts of the body concerned in making speech. It includes the positions of the parts of the body necessary for pro-

ducing spoken words, and the effect of air from the lungs as it passes through the larynx, pharynx, vocal cords, nasal passages, and mouth.

**The phonetic ideal** is a language in which every spoken sound is represented by one letter and only one. No language has reached this ideal, but Spanish and Italian are close to it.

German and Spanish add a few marks to letters, because there are not enough letters to cover all the sounds. Italian has only one silent letter, *h*, which is used before *e* and *i* to make the preceding *g* or *c* hard, as in *spaghetti*. French is among the most complex in this respect. It has many spellings for the same sound; four accent marks; and a cedilla for words like *François* that have an *s* sound for *c*.

**English spelling** is difficult because spelling was decided on by printers hundreds of years ago, but speech has continued to change sounds.

English is far from the phonetic ideal. "*Though* he pulled *through* a *cough* and *hiccough,* he still had a *rough* night on a *bough,*" contains six different sounds spelled the same. Every vowel has several sounds as in cake, hat, bath, arm. *A* and *e* have about eight sounds. English-speaking people have tried in some ways to reproduce sounds phonetically. For example, *pin* and *pine*, and *pinning* and *pining,* mark the difference in the *i* sounds. However, there is no reason for a spelling difference between *till* and *until*.

**An international phonetic alphabet** has been compiled by experts to represent the various sounds. These symbols can be applied to all languages. In English, they show clearly the difference between the *th* of *ether* (θ) and the *th* of *either* (ð), and between the *ssi* of *mission* (ʃ) and the *si* of *vision* (ʒ). Another symbol shows the *ng* sound of *sing* (ŋ).

Phonetic symbols are especially useful for vowel sounds, as in the *a* of *father* (ɑ) and the *a* of one pronunciation of *ask* (a), or the *u* sound of *pull* (u), the *oo* sound of *pool* (u), and the stressed *u* sound of *sun* (ʌ). The most common sound in English is that of *e* in agent. It appears in print as *a*round, mom*e*nt, char*i*ty, porp*oi*se, act*o*r and circ*u*s. The symbol for it is an inverted e (ə), called a *schwa*.

**Reformed spelling** has been tried by many persons, to make spelling come closer to sound. Its value is doubtful, because pronunciation changes rapidly. A series of technical dictionaries would be necessary to explain the language if simplified spelling were widely adopted throughout the world.

See also **Pronunciation.**

**Phonics** is the association of letters or combinations of letters with their appropriate speech sounds. Phonics also includes understanding the principles that govern the use of letters in words. In reading, phonics helps us understand the sound of a word that is unfamiliar. In spelling, phonics helps us write the appropriate letters for the sounds we hear.

Phonics can be taught synthetically or analytically. In the *synthetic* approach, a child learns the sounds of individual letters and letter combinations, usually before learning to read. With an unfamiliar word, the child *synthesizes,* or sounds out, the sounds that make up the word. In the *analytic* approach, a child develops a vocabulary of words he or she knows by sight. This is done while learning to read. The child eventually analyses the words for their sounds. In this way, the child understands both the sound of the letters and the reasons some letters are used instead of others. The child then applies these reasons, or *principles,* and learns to recognize the sounds of new words. Most educators prefer the analytic approach.

In reading, phonics has both advantages and limitations. A knowledge of phonics makes it possible to reconstruct the sounds of many words not known by sight. This is particularly true for languages in which each letter or symbol represents only one sound and each sound is represented by only one letter. In English, the relation between sounds is not consistent. Thus, phonics has limitations if it is the only means used to learn unfamiliar words. Different letters may represent the same sound, as in *meet* and *meat,* or the same letter may stand for different sounds, as the *a* in *fall, fat, fate,* and *father.*

Teachers consider phonics an essential part of any effective reading programme. But because of the many inconsistencies in the English language, they recommend using additional aids to help a reader improve his or her pronunciation of unfamiliar words. For example, the reader may be taught to identify new words by their prefixes, suffixes, roots, and syllables.

See also **Phonetics; Pronunciation; Reading.**

**Phonograph.** See **Record Player.**

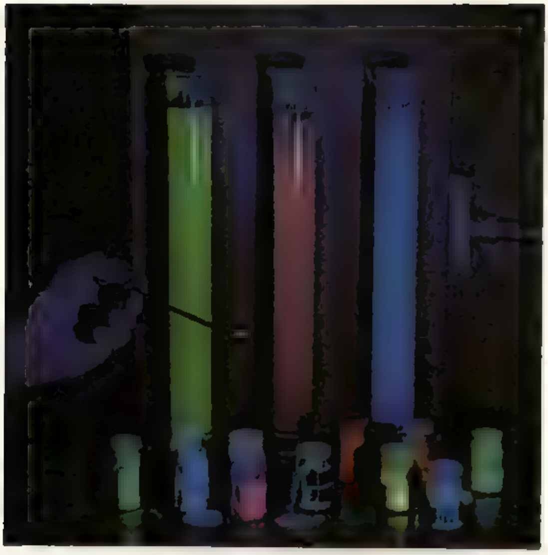
**Phosphate** is any one of a number of chemical compounds that contain phosphorus and oxygen in the phosphate group, $PO_4^{3-}$ Phosphates are necessary to the growth of plants and animals, and have extensive use as fertilizers. The phosphate mineral hydroxyapatite is an important part of bones and teeth. At one time phosphates were widely used in the manufacture of detergents. In these products, phosphates help remove dirt and soften hard water.

Phosphates in detergents appear to contribute to water pollution. These compounds in waste water fertilize simple plants called *algae,* which grow in lakes and streams. As the algae die, their decay pollutes the water. During the 1970's, some cities and states in the United States banned the use of phosphate detergents. Several manufacturers have introduced detergents without phosphates.

There are large amounts of natural phosphates. They occur in phosphate rocks, mostly combined with the elements calcium and magnesium. They also occur in the remains of animals and of plants. The principal producers of phosphate rock include China, Morocco, and the United States. Phosphate rock is the chief source of fertilizers containing phosphates. A soluble fertilizer, superphosphate, acts much faster than the pulverized rock. It is made by crushing the rock and treating it with sulphuric acid.

See also **Fertilizer; Nauru; Detergent and soap; Phosphoric acid.**

**Phosphor** is a substance that absorbs certain types of energy and gives off part of that energy as visible light. The energy can be supplied by X rays, cathode rays, ultraviolet radiations, or alpha particles from radioactive substances. If luminescence stops immediately after the energy supply is removed, the material is said to be *fluorescent.* If the light continues for some time, the mate-



**Phosphor materials,** used in colour television picture tubes, glow with different colours when struck by streams of electrons.

rial is *phosphorescent.* Phosphors are used in fluorescent lamps, television tubes, and other devices.

See also **Fluorescence; Fluorescent lamp; Phosphorescence.**

**Phosphorescence** is the light certain substances give off when they absorb energy. The general term for the emission of light due to the absorption of energy is *luminescence.* The term *phosphorescence* refers to luminescence that continues after the energy source has been removed. It may last for seconds, hours, or even days. Luminescence that occurs only while a substance is exposed to energy is called *fluorescence.* See **Fluorescence; Luminescence.**

The energy to create phosphorescence may be supplied by various sources, including electric current, ultraviolet rays, X rays, and certain chemical reactions. The colour of the phosphorescent light depends on the substance and the form of energy it absorbs.

Familiar phosphorescent substances include Celluloid, egg shells, ivory, and paraffin. Many gems, minerals, and pigments phosphoresce strongly when excited by nuclear or ultraviolet radiations. Some materials phosphoresce simply by being exposed to sunlight. Manufacturers may use such materials in toys or the markings on watch faces that glow in the dark. The phosphorescence given off by living things is called *bioluminescence* (see **Bioluminescence**).

For a substance to phosphoresce, the electrons in its atoms must absorb energy. This energy causes the electrons to become *excited*—that is, to jump to a higher energy level. Excited electrons are unstable. To drop back to their normal energy level, the electrons give off the excess energy as light. But in a phosphorescent substance, the electrons become trapped temporarily between the excited energy level and the normal level.

Phosphorescence serves as a valuable tool in the scientific examination of various materials. For example, doctors can diagnose certain diseases by studying the phosphorescent light given off by human tissue exposed to ultraviolet rays. Archaeologists can learn the age of pottery by heating the pottery and measuring the amount of phosphorescence that results.

Phosphorescent substances are used to create the image on the display screens of computers and television sets. Tiny dots of phosphorescent material called *phosphors* coat the screens. They glow when a beam of electrons is aimed at them. We see a continuous picture because the dots phosphoresce briefly as the beam sweeps back and forth across the screen.

**Phosphoric acid** is the most common acid of phosphorus. Manufacturers use it to make inorganic phosphate compounds, fertilizers, soft drinks, and flavouring syrups. Its normal sodium salt, $Na_3PO_4$, is an excellent water softener. Metal surfaces treated with phosphoric acid are highly resistant to corrosion.

Most phosphoric acid is made by one of two processes. In the wet process, naturally occurring phosphate minerals are treated with sulphuric acid. In the thermal process, pure phosphorus is burned to make phosphorus pentoxide, $P_2O_5$, which produces the acid when dissolved in water. Pure phosphoric acid forms colourless crystals that melt at about 42.4° C. It is very soluble in water. Technically, phosphoric acid is called *orthophosphoric acid.* Its chemical formula is $H_3PO_4$.

**Phosphorus** is a nonmetallic chemical element with the symbol P. It is found in every living cell and has many industrial uses. In nature, phosphorus occurs only in compounds called *phosphates.*

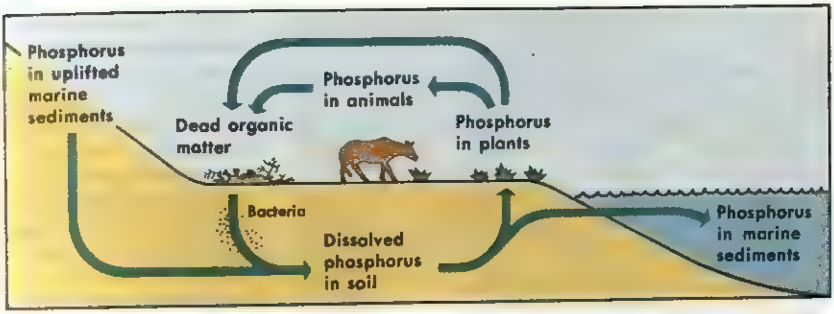
Plants and animals need phosphorus to live, as well as for normal growth. Plants absorb phosphorus from soil and use it in photosynthesis. People and animals take in phosphorus by eating plants and such foods as meat, milk, and eggs. About four-fifths of the phosphorus in the human body occurs in the bones and teeth. Phosphorus makes up an important part of *adenosine triphosphate* (ATP), a compound that stores energy in body tissues.

A chief source of phosphorus for industrial use is *phosphate rock,* also called *phosphorite.* Countries that mine much phosphate rock include China, Morocco, and the United States. Manufacturers make two forms of phosphorus from phosphate rock—*white phosphorus* and *red phosphorus.* They are called *allotropes* of phosphorus (see **Allotropy**).

White phosphorus is a soft, waxy solid. To prepare it, manufacturers first produce phosphorus vapour by heating phosphate rock in the presence of coke and sand. The vapour is then condensed into white phosphorus. White phosphorus combines readily with other elements. It also spontaneously ignites in air at about room temperature. For this reason, white phosphorus is usually stored underwater. White phosphorus is very poisonous and, when touched, can cause serious burns. It is also *phosphorescent*—that is, in the dark, it glows when exposed to air. Manufacturers use white phosphorus in making such products as steel, plastics, insecticides, fertilizers, drugs, animal feed, water softeners, and detergents. Detergents made with white phosphorus are rich in phosphates. But phosphates from detergents can enter lakes and rivers through sewage and contribute to the *eutrophication* of the lakes and rivers. Eutrophication results in the death of fish and other aquatic life (see **Eutrophication**).

**The phosphorus cycle**

The phosphorus cycle is *imperfect* because not all phosphorus returns to uplifted marine sediments, where the cycle began. Geological forces may someday elevate sediments that form in shallow parts of the seas. But phosphorus is permanently lost if it is carried into deeper waters.




Red phosphorus, a brownish-red powder, is made by heating white phosphorus or by exposing it to sunlight. Red phosphorus does not burn, or combine with other elements, as readily as white phosphorus. Red phosphorus is used in making safety matches and pesticides.

Another allotrope of phosphorus, called *black phosphorus,* resembles graphite. It can be made by heating white phosphorus under very high pressure. Black phosphorus combines less readily with other elements than do white and red phosphorus.

The atomic number of phosphorus is 15, and its weight is 30.97376. White phosphorus melts at 44.1° C and boils at 280° C. The German alchemist Hennig Brand discovered phosphorus in 1669.

See also **Isotope** (diagrams); **Phosphate; Phosphoric acid; Phosphorus cycle.**

**Phosphorus cycle** is the circulation of phosphorus among the rocks, soil, water, and plants and animals of the earth. Human beings and all other organisms must have phosphorus to live. In nature, most phosphorus occurs in *phosphate rock,* which contains phosphate ions ($PO_4^{\equiv}$) combined with calcium or magnesium. Phosphate rock forms as sediments at the bottom of the seas. Some of these sea-floor sediments were uplifted during the formation of mountain ranges.

The weathering of phosphate rock that has been elevated above sea level supplies phosphates to the soil. Plants absorb dissolved phosphate from the soil. Human beings and other animals obtain phosphorus from the plants or animals that they eat. After plants and animals die, certain bacteria break down the dead organic matter and return phosphorus to the soil. Organisms may recycle phosphorus many times before it is finally washed to the sea and is trapped once again in marine sediments. Extremely slow geological forces eventually lift some of these sediments, and another cycle begins.

Human beings accelerate the weathering process by clearing forests, which protect land from erosion. People also interfere with the phosphorus cycle by mining phosphate rock for the manufacture of such products as detergents and fertilizers. The use of these products greatly increases the rate at which phosphorus returns to the sea. Large quantities of phosphate that come from detergents and fertilizers contribute to water pollution. See **Phosphate.**

See also **Phosphorus; Ecology** (Cycling of materials).

**Phossy jaw.** See **Match** (The first matches).

**Phot.** See **Foot-candle.**

**Photocathode.** See **Image orthicon.**

**Photocell.** See **Electric eye.**

**Photochemical smog.** See **Smog** (Photochemical smog).

**Photochemistry** is a branch of chemistry that deals with the chemical reactions that result when the molecules of a substance absorb light. A molecule changes photochemically only if it absorbs light, not if light passes through it or is reflected.

Light is absorbed in tiny amounts of radiant energy called *photons.* The energy of a photon depends on the wavelength of the light. After absorbing a photon, a molecule increases in energy and is in an *excited state.* In most cases, the molecule remains in that state only a millionth of a second or less. Sometimes the molecule returns directly to its normal state by losing the gained energy in collisions with other molecules or by releasing it as light. But if the wavelength of the absorbed light photon is short, as in visible light, the molecule may have received enough energy to undergo unusual chemical reactions while in the excited state.

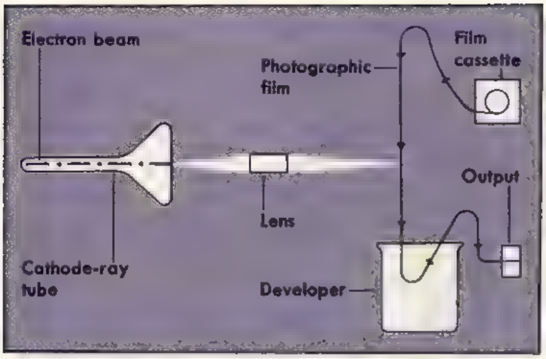
Photochemical reactions are part of many natural processes. In photosynthesis, for example, green plants absorb sunlight. The plants use this light energy to make food out of carbon dioxide from the air and water from the soil (see **Photosynthesis**). Plants thus convert the radiant energy of light into the chemical energy of food. Through geological processes, plants may be converted into coal or petroleum. As these fuels are burned, the light energy stored in the plants millions of years before is released.

Many industrial processes also involve photochemical changes. In photography, for example, some of the silver salts in photographic film absorb light when a photograph is taken. The absorbed light chemically changes these salts. When the film is developed, the changed salts produce dark images on the negative.

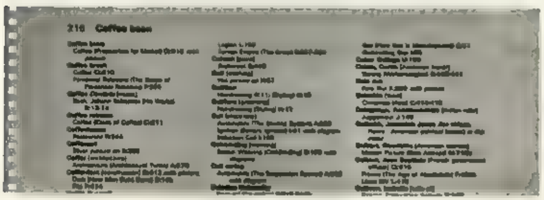
Much research in photochemistry today involves the development of technological uses of solar energy. Some photochemists are seeking ways to imitate the process of photosynthesis with artificially created molecules. These chemists hope to convert sunlight into electricity in a more efficient way than is now possible. Other photochemists are studying methods for using sunlight to produce such fuels as hydrogen gas and methanol. Some of these methods involve splitting molecules of water with solar power.

See also **Light; Quantum mechanics; Solar energy.**

**Photocomposition,** also called *phototypesetting,* is any of several methods of *setting* (assembling) type on photographic paper or film. The paper or film is used to prepare printing plates. Photocomposition plays an im-




**Cathode-ray tube photocomposition** is a method of setting type photographically. A cathode-ray tube projects beams of electrons that create images of type characters. The images are focused through a lens onto film, *above.* The film is developed into a photographic positive of the type characters, *below.*



portant role in the production of most printed materials, including books, magazines, and newspapers.

There are several kinds of phototypesetting machines. All create photographic images of letters, numbers, and other type characters. Some have two basic units—a keyboard unit and a photographic unit. The material to be set is typed on the keyboard and stored on a magnetic disc. This disc operates the photographic unit. This unit contains a film negative of a *fount,* a set of all the characters of one style of type. Light is projected through the desired characters on the negative, and a photographic positive of the characters is produced.

Some phototypesetting machines can be linked to computers. Such machines set as many as 4,500 characters per minute. The computers handle many tasks that otherwise would be done by people. For example, they hyphenate words when necessary to produce *justified* lines of type. In justified lines, the words are spaced so that the right-hand margins are aligned.

Other phototypesetting machines operate by *cathode-ray tube* (*CRT*) *photocomposition.* These machines have a cathode-ray tube, a device that forms images of type characters according to instructions from a computer. The instructions for each character in a fount are stored in a part of the computer called the *memory.* The material to be set is fed into the computer and also stored in the memory. Using the information from the computer's memory, the cathode-ray tube projects beams of electrons that reproduce the images of the characters on a screen. The images are then focused through a lens onto photosensitive paper or film. Today, *high-resolution* CRT machines produce a very sharp image and do not require a lens. Some CRT machines can set up to 30,000 characters per minute.

Photocomposition has many advantages over the older method of typesetting, which uses metal type. Photocomposition is much faster, and most phototypesetting machines can enlarge or reduce the size of type from one master fount. The use of computers in photocomposition simplifies many typesetting operations. For example, changes in a line or page of text can be made without rekeying the entire line or page. The new information is simply fed into the computer, which makes the necessary changes in its memory.

See also **Printing; Type.**

**Photoconductive cell.** See **Electric eye.**

**Photocopying** is any of several techniques that use light-sensitive materials to copy documents or illustrations. The chief methods of copying are (1) electrostatic copying, (2) projection copying, and (3) contact copying. Most copy machines use the electrostatic method.

**Electrostatic copying** was invented in 1938 by Chester F. Carlson, an American physicist. Unlike earlier methods, which require liquid developers, Carlson's process is completely dry. It became known as *xerography,* from two Greek words meaning *dry* and *writing.*

In xerography, a drum, belt, or plate coated with the element selenium or some other light-sensitive material is charged with static electricity. Light reflected from the *original* (the document or illustration to be copied) then passes through a lens. The light strikes the light-sensitive surface, forming on that surface a positively charged image corresponding to the dark areas of the original. The remainder of the surface loses its charge. Next, negatively charged *toner* (powdered ink) is dusted onto the surface. Because oppositely charged materials attract each other, toner sticks to the image. The inked image is transferred to positively charged paper and heated for an instant. The heat melts the toner, creating a permanent copy.

Manufacturers produce a wide variety of electrostatic copiers, from personal copiers that make 5 to 8 copies a minute to units that can generate 135 copies a minute. Special features include automatic document feeding and sorting, image reduction and enlargement, *duplexing* (two-sided copying), colour copying, and stapling. Colour copiers range from machines that produce copies in only two colours (black and one other colour) to units whose copies look like full-colour photographs.

The digital electrostatic copier scans a document, converting it into digital code, which is stored in the copier's memory. The user can then edit the document. The copier can even merge different parts of documents or transmit documents to other digital devices, such as facsimile (fax) machines and personal computers (see **Computer** [How a computer operates]).

**Projection copying** was developed in the mid-1800's. Common projection copiers include the copy camera and the photostat machine. A copy camera performs the steps used to develop and print ordinary photographs. First, the copy camera takes a photograph of the original. The film is then developed by a chemical solution, producing a negative. To make a positive copy, the image on the negative is projected onto positive paper. Finally, the paper is developed to create the copy. Copy cameras are used today to create the negatives used in making *lithographic plates* for printing (see **Photoengraving and photolithography**).

A *photostat machine* does not use photographic film to make a negative. Instead, it projects light reflected from the original directly onto light-sensitive paper. Developing the paper produces the copy. The photostat machine, like any other projection copier, can enlarge or reduce the size of the copy made from the original. One type of photostat machine enlarges and copies images from microfilm onto paper. See **Microfilm.**

**Contact copying** was first used in the mid-1800's. In this method, the original is placed in contact with light-sensitive negative paper and exposed to light. Next, the negative paper is held against positive paper, and the two papers are fed into a contact-copying machine. There, they pass through a developer, such as ammonia vapour or water. The developer brings out the image on the negative and transfers it to the positive paper (the copy). Blueprints, commonly used for engineering drawings, and similar types of duplicates are made using the contact copying method (see **Blueprint**).

See also **Library** (Photocopying).

**Photoelectric cell.** See Electric eye.

**Photoelectric effect** is any effect that results in the transfer of energy from light to an electric current. Such effects are used to measure the intensity of light or to provide a supply of electricity. The three main types of photoelectric effect are the *photoemissive, photoconductive,* and *photovoltaic* effects.

**The photoemissive effect** occurs when a material emits electrons as a result of light falling on it. This effect was used in some early photoelectric cells. These photoemissive cells consist of a glass tube containing a negatively charged electrode called the *cathode* and a positively charged electrode called the *anode* (see **Electrode**). A light-sensitive coating on the cathode causes it to emit electrons when light falls on it. The electrons, which are negatively charged, are attracted to the positively charged anode.

The electron flow is an electric current proportional to the light intensity at the cathode. A light-intensity meter can be constructed by connecting the cell to a current measuring meter.

**The photoconductive effect** occurs when the electric current flowing through a substance increases as a result of light falling on it. The flow of electrons forming the current will vary according to the intensity of the light. Photoelectric cells using this effect usually contain a piece of cadmium sulphide or selenium. A photoconductive cell connected to a battery and current meter is used in many cameras to measure light intensity.

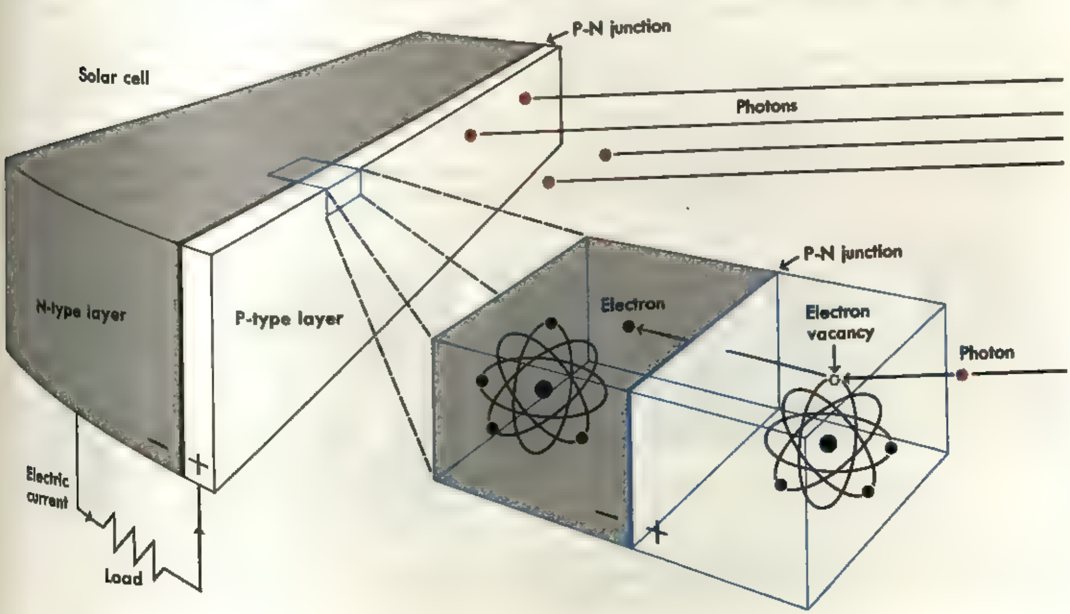
**The photovoltaic effect** occurs when light falling on the *junction* (boundary) between two substances causes a transfer of electrons from one side of the junction to the other. One material thus acquires an excess of electrons and becomes negatively charged. The other material, having a deficiency of electrons, becomes positively charged. As in a battery, this imbalance produces an *electromotive force,* which can be used to make a current flow around a circuit.

Some photoelectric cells using the photovoltaic effect have junctions of copper and red copper oxide. But most modern types use junctions of P- and N-type semiconductors. Photovoltaic cells are used in some photographic light meters and have the advantage of needing no supply of electricity. A simple light meter can be made by connecting a voltmeter to a photovoltaic cell to measure the strength of the electromotive force produced. Photovoltaic cells are used in calculators and in spacecraft as solar cells for producing energy.

See also **Electric eye; Light meter; Photomultiplier tube.**

**Photoelectric effect of light**

The energy of light photons creates electric current in a solar cell. A photon releases an electron from an atom in the P-type layer. The electron is driven across the P-N junction into the N-type layer. The electron flows out of the cell, through a load, and back to the P-type layer.



**Photoengraving and photolithography** are processes used to make printing plates or cylinders for the three major methods of printing. These methods are (1) letterpress, (2) offset lithography, and (3) gravure. On letterpress printing plates, the parts that print are above the nonprinting parts. On offset lithographic plates, the printing parts and the nonprinting parts are on the same level. On gravure cylinders and plates, the printing parts are below the nonprinting parts. For details of the three printing methods, see **Printing.**

Photoengraving is used to make letterpress printing plates. Photolithography is used to make offset lithographic plates. Gravure cylinders and plates are made by a process similar to photoengraving. Many authorities call this process *photogravure.*

### Letterpress photoengraving

Letterpress photoengraving produces printing plates by means of photography and *etching* (engraving with acid). The process is used mostly to reproduce illustrations. It also can be used to create *relief* (raised) letters for printing words, but type is usually used. There are two chief kinds of photoengraved plates: (1) line engravings and (2) halftone engravings.

**Line engravings** are made from *copy* (the original material to be reproduced) that consists only of solid lines or solid areas. Such copy includes diagrams and charts, pen-and-ink drawings, and proofs of type.

*Making the negative.* The first step in making a line engraving is to photograph the copy to get a *negative* (piece of developed film that shows the copy's light and dark areas in reverse). A photoengraver places the copy in front of a large camera. The copy is then flooded with intense white light from arc or fluorescent lamps. The camera is adjusted so as to get a negative the exact size needed for the printed reproduction. After the copy has been photographed, the negative is developed. The solid lines and areas on the copy are transparent on the negative. The white background areas on the copy are opaque on the negative.

The photoengraver then prepares a *flat* (or *foil*). The negative is fastened, along with any other negatives, to a sheet of plastic. The flat is then placed emulsion or coated side down on a metal plate that has been coated with a substance sensitive to light. Usually zinc, copper, or magnesium plates are used. The flat and plate are put in a *vacuum printing frame.* The vacuum creates airtight contact between the plate and flat.

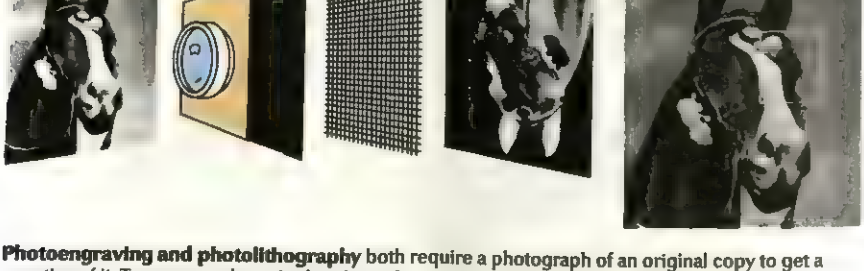
The negative now serves as a stencil. Light rays from powerful lamps pass through the transparent (image) parts of the negative. The rays harden the light-sensitive coating on the plate under the transparent parts and make it insoluble. The opaque parts of the negative block the light, and the coating under these parts stays soft and soluble. The plate is then soaked in water to wash away the soft, unexposed parts of the coating. Only the hard image, which is acid resistant, remains on the developed plate.

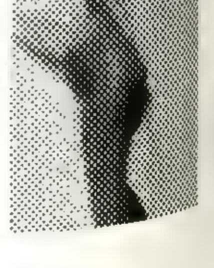
*Etching the plate.* The photoengraver next gives the plate several acid baths. Each dip into the acid is called a *bite.* With each bite, the acid etches away a little more of the background of the plate. After the first bite, and before each succeeding bite, the photoengraver brushes the sides of the image with an acid-resistant powder called *dragon's blood.* This powder protects the image from being undercut by the acid. The photoengraver gives the plate as many powderings and bites as are needed to make the image stand in sharp relief.

Many photoengravers use a process called *powderless etching.* It requires only one bite, eliminating the repeated powderings. The developed plate is placed face down in a machine that throws acid against the plate. The sides of the image are not undercut because the acid does not hit them directly. In addition, the acid contains special chemicals that form a protective film on the sides of the image during etching.

After etching the plate, the photoengraver mounts it on a wood, metal, or plastic block so that it is the same height as type, 23.3 millimetres. The plate is then ready to be printed with the type.

**Halftone engravings** are made from *continuous tone* copy. Such copy has a range of tones, and includes oil paintings, watercolours, and black-and-white and colour photographs. To reproduce the tones, the photoengraver creates an optical illusion on the printed page. If you were to look through a magnifying glass at a black-and-white photograph in a book, newspaper, or magazine, you would see that it is made up of a large number of tiny dots. The areas with large dots close together are seen as dark grey or black shadows. The areas with small, widely spaced dots appear as highlights of light grey or white. The photoengraver creates





**Photoengraving and photolithography** both require a photograph of an original copy to get a negative of it. Tone copy, *above,* is shot through a screen, which breaks up the image into tiny dots on the halftone negative. The enlargement, *above right,* shows the dot pattern.

the dots by photographing the copy through a halftone screen, which breaks up the image.

*The halftone screen* consists of two sheets of glass. Each sheet is ruled with parallel opaque lines. The sheets are cemented together so that the lines cross at right angles, forming squares. The number of lines per centimetre determines the coarseness or fineness of the screen, which, in turn, determines the density of the dots. There may be 18 to 160 lines per centimetre, but screens with 24 to 60 lines per centimetre are most common. The paper used in printing determines the size of the screen. On rough paper, which is more absorbent, a coarse screen reproduces an illustration better. On smooth paper, a fine screen is better for reproduction. Most newspapers are printed on rough paper, and use a screen of about 26 lines per centimetre. Most magazines are printed on smooth paper, and use screens of about 52 lines per centimetre.

*Making the negative.* The photoengraver places the copy in front of the camera, illuminates the copy, and adjusts the camera for the desired negative size. A halftone screen is then inserted between the film and the camera lens. The screen permits light reflected from the copy to pass through only the spaces between the lines onto the film. Thus, the screen breaks the light into tiny dots. The lightest areas in the copy reflect the most light and cast the biggest, most closely spaced dots on the negative. The darkest areas reflect the least light and produce the smallest, most widely spaced dots. These sizes are reversed when the images are transferred from the negative to the metal plate. For example, the areas with the largest black dots on the negative block out the most light and create the smallest, most widely spaced dots on the plate.

*Etching the plate.* The halftone negative is handled in much the same way as the line negative. It is fastened to a flat and printed on a metal plate. The plate is developed, and the unexposed parts of the coating are washed away.

Halftone etching also resembles line etching, but it is more delicate. The tones of the original copy must be reproduced, the spaces between the tiny dots must be etched to the right depth, and the sides of the dots must not be undercut.

**Colour engravings.** To reproduce full-colour copy, such as paintings and colour photographs, the photoengraver photographs the copy four times to get a separate negative of the yellow, *magenta* (a purplish red), *cyan* (a blue), and black in the copy. Plates are made from the negatives. Each plate prints yellow, magenta, cyan, or black ink. See **Printing** (Printing in colour).

**Other methods** for making letterpress engravings include the use of electronic engraving machines and photopolymer plastic plates.

*Electronic engraving machines* use a tiny beam of light that scans the original copy. Light reflected from the copy creates impulses that activate a V-shaped tool called a *stylus.* The stylus cuts or burns lines or dots into a metal or plastic plate according to the strength of the impulses. Where the copy is whitest, the impulses are strongest and the stylus cuts deepest. In shadow areas, the stylus makes a shallow cut.

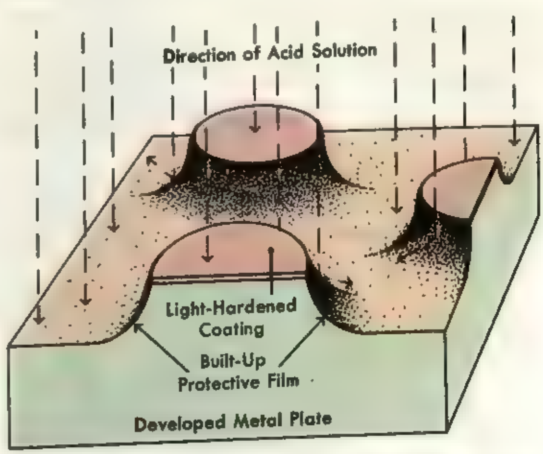
*Photopolymer plastic plates* have a layer of light-sensitive plastic on a metal base. To make a line or halftone engraving, the plastic is simply exposed to a negative under intense light. The plastic hardens according to how much light passes through the negative. The areas that receive the most light (the image areas) are the hardest. The plate is sprayed with a chemical solution, which washes away the soft, unhardened plastic. The hard image stands in sharp relief.

### Photolithography

Photolithography is a photographic and chemical process used to make plates for printing by offset lithography. On these plates, the printing images are on the same level as the nonprinting parts. Offset lithography is based on the fact that grease and water do not mix. The printing images are chemically treated so that when the plate is on the press, they repel water from water rollers and accept greasy ink from ink rollers. The nonprinting parts on the plate accept water and repel ink.

On the press, the inked images are not transferred directly from the plate to the paper to be printed. The images are first *offset* (transferred) to a rubber-covered cylinder, which then offsets them to the paper. Offset lithography is often called simply *litho* or *offset.*

**Making the negative.** The first step in photolithography is to photograph all the copy, including proofs of type. The photographic work is similar to that used in photoengraving. The line copy, which includes type proofs, and the continuous tone copy are photographed separately. The continuous tone copy is photographed through a halftone screen in order to get the dot pattern. After the negatives have been made, they are *stripped* (pieced) together on a flat exactly as the type and illustrations are to appear in print. After the flat has been prepared, the images on it are transferred to an offset plate.




**Powderless etching** of a developed metal plate creates the relief image with one acid bite. In an etching machine, acid splashes directly against the face of the plate, and eats away the nonimage background. The sides of the image are not undercut because the acid strikes them indirectly. Chemicals added to the acid build up a protective film along the sides.

**Making the plate.** Many kinds of offset plates are used, but they fall into three main groups: (1) surface plates, (2) deep-etch plates, and (3) bimetal plates.

*Surface plates* are usually made of a thin sheet of aluminium covered with a light-sensitive coating. The platemaker can either apply the coating or use *presensitized plates.* Presensitized plates are coated when purchased, and can be stored in the dark and used when desired. If the printer coats the plates, they must be used shortly thereafter, because the coating hardens quickly. A hard coating will not take an image.

The negative flat is placed on the plate, and both are put in a vacuum printing frame. Light from high-intensity lamps shines through the negatives, hardening the coating under the transparent parts. The opaque parts of the negatives block the light, leaving the coating under them soft. *Developing ink* is spread over the exposed plate. The plate is then rinsed with water, and the soft, nonprinting parts are washed away. Only the hard, ink-receptive, water-repellent images remain.

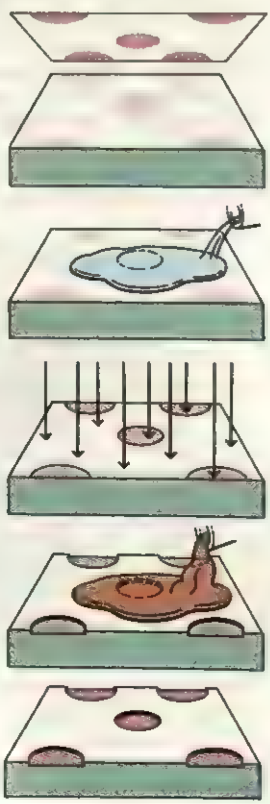
*Deep-etch plates* are made in much the same way as surface plates. But a positive flat is used instead of a negative flat. Positives can be made by rephotographing the negatives or by printing them on film. By using a positive flat, the light-hardened areas become the nonprinting areas. The image areas have the soft coating. The plates are washed after exposure, and the soft coating in the image areas is dissolved. Next, acid is applied to eat away a little of the exposed metal in the image areas. The slightly sunken images are then lacquered to make them attract ink. The coating on the nonprinting parts is scrubbed off.

*Bimetal plates* are made of two metals, one on top of the other. One metal is copper, which has a natural attraction for ink. The second metal can be chromium, aluminium, or some other metal that has an attraction for water. Copper can be the top or bottom metal. Bimetal plates can use negative or positive flats. One type of widely used plate has chromium over copper. The chromium is exposed to a positive flat. After the plate has been washed, the chromium is exposed in the image areas. The images are then etched through the chromium to the ink-receptive copper. The coating is scrubbed off the nonimage areas, exposing the water-receptive chromium.

## Photogravure

Photogravure produces printing images below the nonprinting areas. The process uses heavy engraved copper-plated cylinders that are placed on the press, or thin engraved copper plates that are clamped around a cylinder on the press. In printing, the sunken images are filled with ink as the rotating cylinder dips into a trough of ink. A thin blade wipes off the excess ink from the nonprinting surface. Paper is then pressed against the cylinder, and the ink is transferred to it.

### Making a deep-etch offset plate



**Exposure.** The metal plate and film positives are exposed under bright light. The light hardens the coating on the areas of the plate that lie under the *transparent* (nonprinting) parts of the positives.

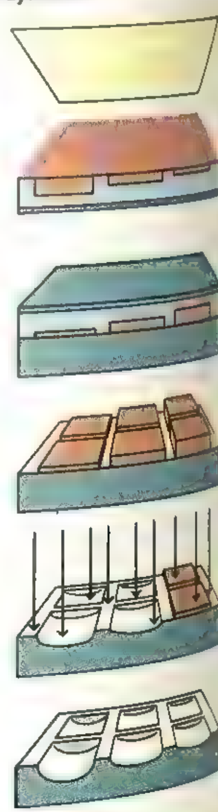
**Development.** The plate is washed to remove the soft parts of the coating, which are the image areas. The hard coating remains on the nonimage areas of the plate.

**Etching.** Acid bites slightly into the exposed metal that makes up the image areas. The hard coating protects the plate's nonimage areas from the bite of the acid.

**Lacquering.** The etched plate is treated with lacquer to make the images attract greasy ink. The coating on the nonprinting parts of the plate is scrubbed off.

**Finished plate** has slightly sunken images. On the press, they repel water and accept ink. The nonprinting parts accept water and repel ink.

### Making a gravure plate or cylinder



**Exposure.** The screened carbon tissue is exposed to film positives. The little squares of gelatin that cover the tissue harden according to how much light passes through the light and dark areas of the film.

**Transfer.** The carbon tissue is dampened, and then transferred gelatin side down to the copper plate or cylinder on which the printing images are to be etched.

**Development.** The carbon tissue is developed in water, and the tissue's paper backing is stripped away. Gelatin squares of varying thickness are left on the metal.

**Etching.** Acid quickly penetrates the thin gelatin squares and bites deep cells in the copper. It eats through the thick gelatin squares slowly and bites shallow cells.

**Finished plate** has thousands of cells. The deepest hold the most ink and print dark tones. The shallowest print light tones.

**Making the negative.** All copy to be reproduced by gravure printing must be photographed. The photographic work is much the same as for letterpress and litho, except that continuous tone copy is not photographed through a halftone screen. After the negatives have been made, film positives are made from them.

The positives are assembled exactly as the type and illustrations are to appear in print. But then, instead of exposing the positives directly onto a light-sensitive plate, they are exposed onto a sheet of *carbon tissue*. This is a sheet of paper covered with light-sensitive gelatin that has already been exposed to a *gravure screen*. The gravure screen is the opposite of the halftone screen. Instead of black lines crossing to form transparent squares, transparent lines cross to form opaque squares. After the carbon tissue has been exposed to the screen, the tissue has a *latent* (hidden) image on it of light-hardened crosslines.

The positives are then printed on the screened carbon tissue. Light passes through the positives, hardening the little squares of soft gelatin to varying degrees. The darkest parts of the positives allow the least light to pass through. The gelatin squares remain softest under these parts. The lightest parts of the positives allow the most light to strike the gelatin. The squares become hardest under these parts.

**Etching the plate or cylinder.** The carbon tissue is placed gelatin side down on the copper plate or cylinder, and developed in water. The water soaks through the paper backing and dissolves the soft gelatin next to the paper. The paper is removed. The tissue is further treated with water until all the soluble gelatin has been washed away. Thousands of little gelatin squares of varying thickness remain on the metal. The thickest squares were the whitest areas on the positives. The thinnest squares were the shadow areas.

The copper is now etched. The acid bites tiny *cells* (pits) into the metal according to the thickness of the gelatin. It quickly penetrates the thin gelatin squares and bites deeply into the copper. It penetrates the thick squares slowly and bites shallow cells. On the press, the deepest cells hold the most ink and print the darkest tones. The shallowest cells hold the least ink and print the lightest tones.

Photogravure printing can be recognized by the fact that both illustrations and text are made up of tiny dots. In letterpress and litho, it is only the illustrations that appear as dots.

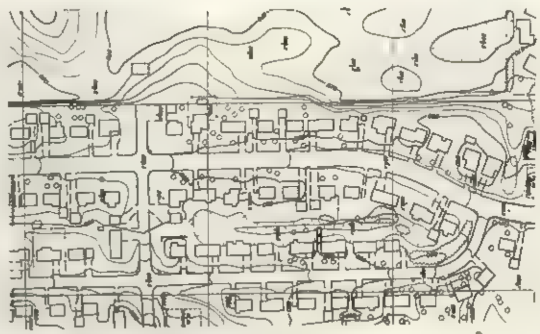
**Related articles** in *World Book* include:

| | |
|---|---|
| Engraving | Offset |
| Etching | Photography |
| Lithography | Printing |

**Photogelatin.** See **Printing** (Collotype).

**Photogrammetry** is the process of making measurements by means of photography. It is most often used in drawing maps on the basis of aerial photographs. It also has many other uses. For example, foresters can determine the amount of timber in a forest by examining aerial photographs of the area.

Photogrammetrists begin their work by obtaining photographs of the area or objects to be measured. The photographs may be taken on the ground or from an aircraft or spacecraft. Photogrammetrists generally work with ordinary photographs. But they also use pictures produced by radar or by *remote sensors,* which measure features using wavelengths outside the visible range. *Infrared sensors,* which measure heat, are a type of remote sensor. Most photographs used in mapmaking are taken from an aeroplane by a special type of camera. The camera takes photographs of overlapping sections of the area to be mapped.



**Photogrammetry** is used to draw maps based on aerial photographs. A photogrammetrist uses a device called a *stereoplotter* to trace the contours from an aerial photograph like the one shown at the top. The contour map that results, *bottom,* shows features of the area in the correct position and proportions.

To obtain accurate measurements from aerial or other photographs, a photogrammetrist must correct any distortion in the pictures. In an aerial photograph, for example, a hill appears larger than a valley of equal area. Such distortion occurs because an airborne camera is closer to hilltops than to valleys. Photogrammetrists correct such errors with a device called a *stereoplotter*. This device uses photographs of an area taken from two locations to create a three-dimensional image. Photogrammetrists also use the stereoplotter to draw a map on the basis of the image.

Photogrammetry started in 1859, when Aimé Laussedat, a colonel in the French Army, announced the first successful use of photographs in surveying. During the 1960's and 1970's, United States and Soviet spacecraft took lunar photographs from which photogrammetrists made detailed maps of the moon.

See also **Map; Surveying.**

**Photographic copying.** See **Photocopying.**

Jupiter photographed from spacecraft

Red blood cells photographed through microscope


Magazine advertising

Sports action

**Photography** is a universal means of communication and a valuable tool in many fields. From family snapshots to pictures taken from spacecraft, photographs record the people and things we see, as well as many subjects beyond our range of vision. Photography is also a major art form. In skilful hands, a camera can transform an ordinary scene into an image of exceptional beauty.

# Photography

**Photography** is the process of making pictures by means of the action of light. Light reflected from an object forms a picture on a material sensitive to light. This picture is then chemically processed into a photograph, which provides a representation of the object. The word *photography* comes from Greek words meaning *to write or draw with light.* A photograph is basically a picture drawn with rays of light.

Nearly all photographs are made with cameras. A camera works in much the same way as the human eye. Like the eye, a camera takes in rays of light reflected from an object and focuses them, using a system of lenses, into an image. But the camera records the image on film. As a result, the image not only can be made permanent but also can be seen by an unlimited number of people.

Photography enriches our lives in many ways. From photographs, we can learn about people in other parts of the world. Photographs show us scenes from such historic events as the American Civil War and the first landing on the moon by human beings, and illustrate current events in newspapers and magazines. Photos also remind us of special people and events in our own lives. Millions of people throughout the world take pictures of their family, friends, holidays, and celebrations.

In addition to recording things and people we can see, photographs capture many images outside our range of vision. Cameras can travel where human beings cannot go—beyond the moon, to the bottom of the ocean, and inside the human body. Photographs taken through telescopes reveal distant objects. By using long exposure times, such photographs can record celestial objects that are too faint for the human eye to see. By using a camera in combination with a powerful microscope and highly concentrated light, physicists photograph collisions of subatomic particles. Pictures made on film sensitive to heat radiation provide images of the

Bank robbery recorded by hidden camera

Artistic multiple exposure of dancers

High-speed photo of hummingbirds

Family snapshot

human body and help doctors detect certain forms of cancer and other diseases.

Cameras can also "see" events in a way that the eye cannot. High-speed cameras record action that occurs so rapidly we see it only as a blur. Through this type of photography, scientists examine moving parts of machinery and study hummingbirds in flight. Other kinds of cameras "speed up" processes, such as the growth of a plant or the opening of a cocoon, that take place too slowly to observe.

Scientific research is only one of the many fields in which photography plays an important role. In advertising, photographs are the most widely used means of publicizing products and services. Photography is such an essential part of news reporting that photojournalism has become a specialized field. Photographs for police records and pictures taken with hidden cameras help the police track down criminals. Military leaders use aerial photographs to learn about enemy troop movements and plan battle strategy. Anthropologists and sociologists study photos of various groups of people for clues to patterns of human behaviour.

Some photographs, like great paintings, have lasting value as works of art. Such pictures, through the photographer's imagination and technical skill, are exceptionally beautiful or express significant ideas.

A crude type of camera was developed by about 1500. However, the first true photograph was not made until 1826. Early photographers needed much equipment and a knowledge of chemistry. Gradually, as a result of the scientific and technical discoveries of the 1800's and 1900's, cameras became more efficient and easier to operate. Today, a person can take a picture simply by aiming the camera and pressing a button. An instant camera can produce a photo in about 15 seconds.

Photography can be divided into two general areas—*still photography* and *cinematography*. This article discusses still photography and some techniques used in making home movies. For more about cinematography, see the *World Book* article on **Film industry**.

## *The photographic process*

The process of making a photograph begins and ends with light. Rays of light enter a camera and are focused into an image. The light exposes the film in the camera, causing chemical changes on the film's surface. The exposed film is then treated with certain chemicals in a procedure called *developing*. Finally, light is used to make a print by transferring the image from the film to a sheet of special paper.

There are five principal steps in the photographic process: (1) capturing light rays, (2) focusing the image, (3) exposing the film, (4) developing the film, and (5) making a print. This section describes the process of making a black-and-white photograph. The procedures used for making colour photographs and instant prints are discussed in the *Developing and printing* section of this article.

**Capturing light rays.** A camera is basically a box with a small *aperture* (opening) at one end and film at the other end. The inside of a camera must be completely dark, so that rays of light reach the film only through the aperture. A device called a *shutter* opens when the camera is being used to take a picture. The shutter remains closed at all other times in order to keep light away from the film.

In nearly all cameras, the aperture is part of a lens system. The lens system concentrates incoming rays of light on the film. In this way, the lens gathers enough light to expose the film in only a fraction of a second. Without a lens, the exposure might have to last as long as several minutes.

When the shutter opens, light from an object passes through the aperture and forms an image of the object on the film. Rays of light from the top of the object go through the aperture and strike the lower part of the film. Light rays from the bottom of the object form the upper part of the image. Thus, the image on the film is upside down.

**Focusing the image.** In addition to concentrating the incoming rays of light, the camera lens serves to focus them on the film. As the light rays pass through the aperture into the camera, the lens bends them so that they form a sharp image. The sharpness of the image depends on the distance between the object and the lens, and between the lens and the film. Many cameras have a focusing mechanism that moves the lens forward and backward. In other cameras, the lens is fixed. Such cameras automatically focus on objects at a certain distance from the lens. See Lens.

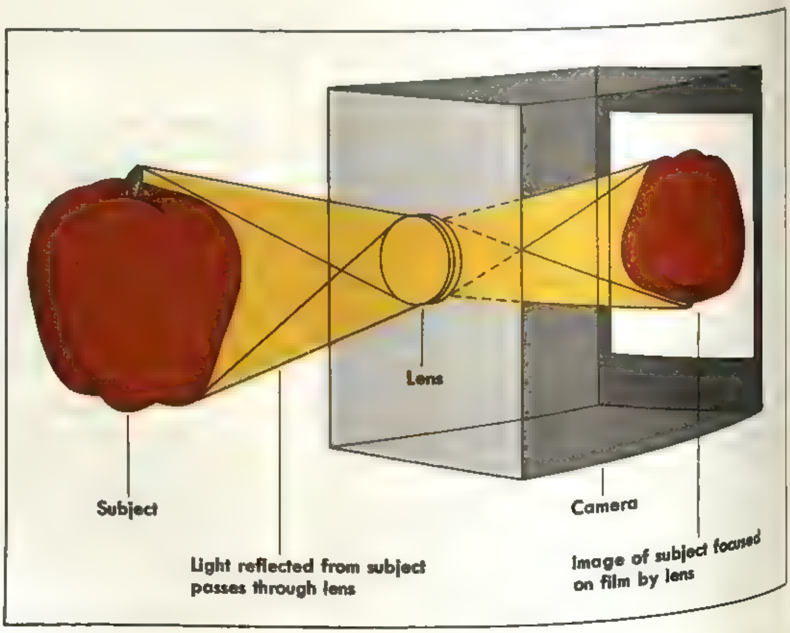
**Exposing the film.** Black-and-white film is a thin sheet of paper or plastic with a coating called an *emulsion*. The emulsion consists of tiny grains of silver salts held together by gelatin, a jellylike substance. Silver salts are highly sensitive to light and undergo chemical changes when exposed to it. The degree of change in the salts depends on the amount of light that reaches them. A large amount of light causes a greater change than does a small amount.

The light that reaches the film varies in intensity. Light-coloured objects reflect a lot of light, and dark colours reflect little or no light. Therefore, the silver salts on the film react differently to different colours. Light from a white or yellow object changes the salts greatly. Light from a grey or tan object changes them only slightly. Black objects do not reflect any light and thus have no effect on the salts. The chemical changes in the silver salts produce a *latent image* on the film. This image cannot be seen, but it contains all the details that will appear in the photograph.

**Developing the film.** After the film has been exposed, it can be removed from the camera. However, it must then be kept away from light because further exposure would destroy the latent image. The film is taken to a darkroom or a photographic laboratory. There, it is treated with chemical developers that convert the silver

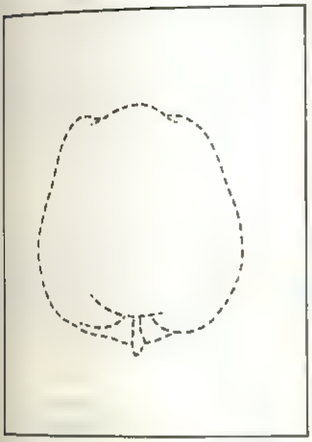
**How an image is formed inside a camera**

A camera is basically a box with a lens at one end and film at the other. Light reflected from a subject enters the camera through the lens, which focuses the rays of light into an image on the film. Light rays from the top of the subject make up the lower part of the image, and those from the bottom form the upper part. Thus, the image on the film is upside down.

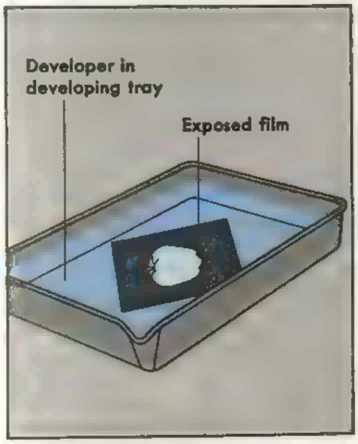


### How a black-and-white photograph is developed and printed

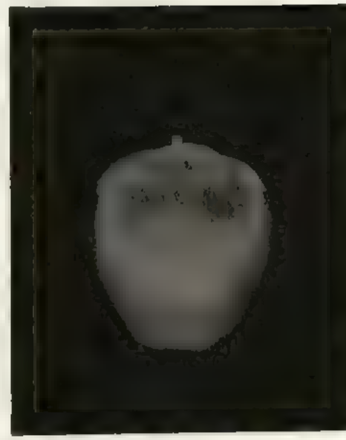
When light enters a camera, it causes chemical changes on the surface of the film. These changes produce an invisible *latent image* of the subject. The latent image becomes visible after the film has been developed. During printing, this image is transferred onto printing paper.



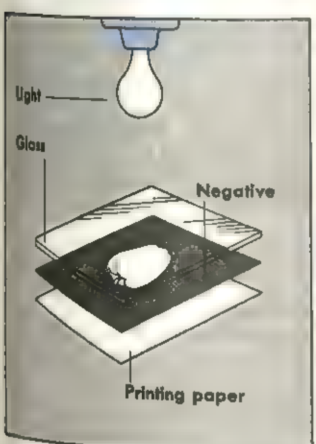
**A latent image** forms after the film is exposed to light. It contains all the details that will appear in the photo.



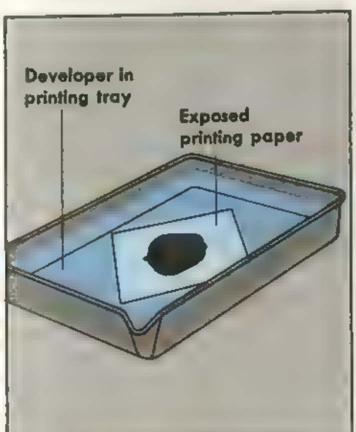

**A developer** converts the exposed silver salts on the film's surface into metallic silver, forming a visible image.



**The developed film,** which is called a *negative,* shows the subject's light and dark tones in reverse.




**Light** passing through the negative exposes the printing paper and forms a latent image on the paper's surface.




**The exposed printing paper** is treated with a developer to produce a visible image known as a *positive.*

**The print,** or *positive,* reproduces the original colours of the subject in various tones of black, grey, and white.

salts on the emulsion into metallic silver. The image on the film then becomes visible.

During development, the silver salts that received a lot of light form a thick deposit of silver and appear dark on the film. The salts that received little or no light form a thin metallic layer or no layer at all. They appear light or clear on the film. Thus, the light colours and dark colours of the subjects photographed are reversed on the film. For example, a piece of coal would appear white on the film, and a snowball would look black. The developed film is called a *negative.* Before further processing, negatives are treated with a chemical solution that makes the image on the film permanent.

**Making a print** is similar to exposing and developing film. Like film, printing paper is coated with a light-sensitive emulsion. Light passes through the negative and exposes the paper, forming a latent image. After development and chemical treatment, the image on the printing paper is visible and permanent.

During exposure, the dark areas of the negative hold back a lot of light. These dark areas show up as light areas on the print. The light and clear areas of the negative let a large amount of light pass through to the printing paper. They appear as dark areas on the print. Thus, the tones of the print reproduce those of the objects photographed.

# Taking photographs

Nearly anyone can take an ordinary photograph. All you need is a camera, film, light, and a subject. First, you look through the *viewfinder* of the camera to make sure that all of the subject will appear in the picture. Next, you press the *shutter release button* to let light from the subject enter the camera and expose the film. Then you use the *film advance,* which moves the film forward through the camera to bring unexposed film into position for the next picture.

To take a truly good photograph, you must follow certain principles of photography. You should try to "see" as the camera does—that is, be aware of the elements that make up a picture. You also should know the effects of different types of light on film. Many cameras have controls that adjust the focus of the image and the amount of incoming light. In using such adjustable cameras, you need to know how the lens works and how exposure can be controlled. These aspects of good photography can be grouped as (1) composition, (2) light, (3) focusing, and (4) exposure.

## Composition

Composition is the arrangement of elements in a photograph. These elements include *line, shape, space,* and *tone* or *colour.* Composition has no fixed rules because it is basically a matter of individual taste. However, some guidelines for the various elements of composition may help you create the kind of photograph desired.

**Line.** There are two principal kinds of lines in photography, *real lines* and *implied lines.* Real lines are physically visible. For example, telephone poles and the edges of buildings form real lines. Implied lines are created by nonphysical factors, such as a pointing gesture or a person's gaze.

Both real lines and implied lines can be used to direct a viewer's eye to various parts of a picture. In the most effective photographs, the lines draw attention to the main subject. The direction of these lines can also be used to reinforce the mood of a picture. Vertical lines, such as those of a tower or a tall tree, may convey a sense of dignity and grandeur. Horizontal lines tend to suggest peace and stillness, and diagonal ones may emphasize energy and tension.

**Shape** is the chief structural element in the composition of most photographs. It enables the viewer to immediately recognize the objects in a picture. Shape also adds interest to composition. The shape of such objects as rocks and seashells is interesting in itself. A combination of different shapes provides variety. For example, an outdoor scene can be made more interesting by contrasting the jagged shape of a fence with the soft curves of hills and clouds.

**Space** is the area between and surrounding the objects in a photograph. Space can be used to draw attention to the main subject and to isolate details in the picture. However, large amounts of space tend to detract from a picture's interest. A general principle is that space should not occupy more than a third of the photo.

**Tone or colour** adds depth to the composition of a photograph. Without this element, the shapes and spaces in a picture would appear flat. In black-and-white photography, the colours of objects are translated into tones of black, grey, and white. These tones help establish the mood of a picture. If light tones dominate the photo, the mood may seem happy and playful. A picture with many dark tones may convey a sense of sadness or mystery.

Colour, like tone, carries an emotional message. In a colour photograph, such bright colours as red and orange create an impression of action and energy. Blue, green, and other softer colours are more restful to the eye and may suggest a feeling of peace. According to many professional photographers, a colour picture should have one dominant colour and a balance between bright colours and softer shades.

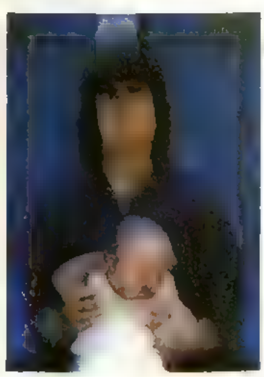
## Light

There are two basic types of light in photography, *natural light* and *artificial light.* Natural light, which is also called *available light* or *existing light,* is normally

**Some common mistakes in taking pictures**

**Cropped heads** result from framing the subject improperly in the viewfinder.

**A tilted view** of the subject appears if the camera is not held in a level position.



**A blurred image** is produced by moving the camera while taking a picture.

**An out-of-focus shot** is caused by poor focusing or standing too near the subject.

**How lines can be used in a photo**

The lines in a photograph can be used to direct a viewer's eye to the centre of interest. They also can reinforce the mood of a scene. Vertical lines may express feelings of dignity and grandeur. Horizontal lines often convey a sense of balance and quiet restfulness. Diagonal lines can suggest energy and possible movement. The lines of a triangle may emphasize action or stillness.

**Vertical lines**

**Horizontal lines**

**The lines of a triangle**

**Diagonal lines**

present in outdoor and indoor locations. Such light comes chiefly from the sun and electric lights. Artificial light is produced by various types of lighting equipment, such as flashbulbs and electronic flash devices. Lighting equipment is discussed in the *Photographic equipment* section.

Natural light and artificial light have certain characteristics that greatly affect the quality of photographs. These characteristics include (1) intensity, (2) colour, and (3) direction.

**Intensity** is the quantity or brightness of light. Photographers measure the intensity of light to determine the *lighting ratio* of a scene. The lighting ratio is the difference in intensity between the areas that receive the most light and those that receive the least. On a sunny day or in a room with bright lights, the lighting ratio is likely to be high. On a cloudy day or in dim indoor light, the ratio is probably low.

The lighting ratio affects the degree of contrast in a photograph. A high lighting ratio may produce sharp images with strongly contrasting light and dark tones. A low ratio creates softer images with a wide range of medium tones. Thus, a high lighting ratio can increase the sense of drama and tension in a picture. A low ratio makes portraits and still-life photographs look more natural.

Most lighting ratios can be used with black-and-white film. In taking colour photographs, however, a high lighting ratio may make some colours appear either faint or excessively dark.

**Colour.** The colour of light varies according to its source, though most of these variations are invisible to the human eye. For example, ordinary light bulbs produce reddish light, and fluorescent light is basically blue-green. The colour of sunlight changes during the day. It tends to be blue in the morning, white at about noon, and pink just before sunset.

Variations in the colour of light make little difference in a black-and-white photograph. However, they produce a wide variety of effects in colour pictures. To control these effects, you can use colour filters on your camera, or you can use colour film that is designed for different types of indoor and outdoor lighting. Such accessories are discussed in the *Photographic equipment* section of this article.

**Direction** refers to the direction from which light strikes a subject. Light may reach a subject from the front, the back, the side, or the top. Light may also strike

### Outdoor lighting

The sun is the main source of light in most photos taken outdoors. When the subject faces the sun, sunlight illuminates the face clearly but may cause the person to squint. Sunlight shining on one side of the subject casts shadows on the other side. These shadows can be filled in with light from a flashbulb or some other source.

**Sunlight from front**

**Sunlight from side**

**Flash fill-in**

a subject from several directions at once. The direction of light greatly affects how the subject looks in the picture.

*Front lighting* comes from a source near or behind the camera. This type of lighting shows surface details clearly. However, it should be avoided for pictures of people because the light makes them squint and casts harsh shadows under their features.

*Back lighting* comes from a source behind the subject. Light from this direction casts a shadow across the front of the subject. To fill in the shadow, additional light from a flashbulb or electronic flash can be used. This technique is called *flash fill-in.* If the back lighting is extremely bright, the picture may show only the outline of the subject. Back lighting can be used in this way to create silhouettes.

*Side lighting* shines on one side of the subject. Shadows fall on the side opposite the source of the light. Flash fill-in can be used to lighten these shadowed areas. Side lighting does not show surface detail as clearly as front lighting does, but it creates a strong impression of depth and shape.

*Top lighting* comes from a source directly above the subject. It is used most frequently in situations where other types of lighting would cause a glare or reflection in a picture. For example, top lighting may be used to photograph fish in an aquarium or objects in a display case or behind a window because the light will not be reflected by the glass.

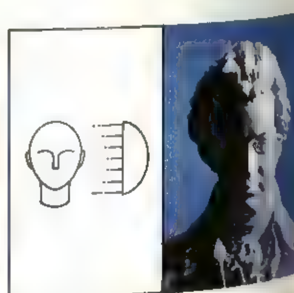
## Focusing

Focusing controls the sharpness of the image in a photograph. The degree of sharpness is determined by (1) the distance between the camera lens and the subject

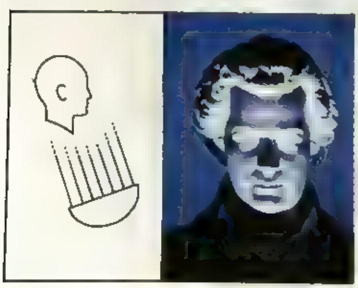
### Indoor lighting

**Front lighting** comes from a source near the camera. It highlights the subject's face, reducing some surface detail.

**Back lighting** comes from a source behind the subject. It throws a shadow over the entire front of the subject.

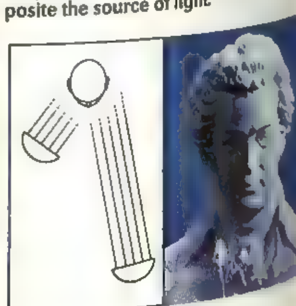


**Side lighting** shines on one side of the subject. It casts shadows on the side opposite the source of light.



**Bottom lighting** comes from below the subject. It produces harsh highlights that distort the subject's appearance.

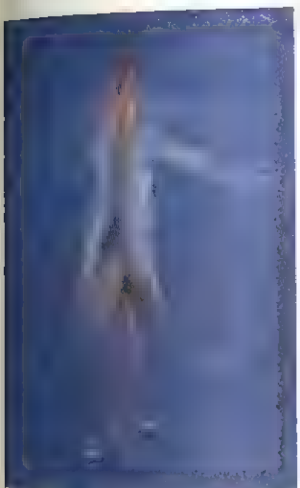
**Top lighting** comes from directly above the subject. It creates an extreme contrast between light and shadow.



**Multiple lighting** can be used to lighten the shadows produced by individual sources of light.

**Using shutter speed to "stop" action**

Shutter speed is the amount of time the shutter remains open during exposure. While it is open, any movement of the subject will be recorded as a blur. At the slow shutter speeds of 1 second or $\frac{1}{60}$ of a second, all or part of a moving dancer looks blurred. At a fast setting, such as $\frac{1}{500}$ of a second, the shutter is open so briefly that the dancer's movement appears "stopped."



Shutter at 1

Shutter at $\frac{1}{60}$

Shutter at $\frac{1}{500}$

and (2) the distance between the lens and the film inside the camera. To form a sharp image of a subject that is close to the camera, the lens must be relatively far from the film. For subjects far from the camera, the lens must be close to the film. See Lens.

In nonadjustable cameras—that is, cameras without a control to adjust the focus—focusing depends on taking pictures at a certain distance from the subject. Most such cameras are designed to focus on subjects more than about 2 metres away. If the subject is closer than about 2 metres, the picture will be blurred.

Adjustable cameras have a focusing mechanism that changes the distance between the lens and the film. Many of these cameras contain a built-in *viewing screen* that provides an image of the subject while the photographer focuses. Various devices on the viewing screen indicate the proper focus. In some cameras, the viewing screen shows two identical images or one image split into two halves. To focus, the photographer turns the focusing control until the double image becomes one sharp image or until the two halves come together. In other cameras, tiny dots appear on the screen until the image has been focused.

## Exposure

Exposure is the total amount of light that reaches the film in a camera. Exposure affects the quality of a photograph more than any other factor. If too much light enters the camera, the film will be *overexposed,* and the picture will be too bright. If there is insufficient light, the film will be *underexposed,* resulting in a dark, uninteresting picture.

In nonadjustable cameras, the exposure is set automatically. Most adjustable cameras have controls that regulate the incoming light. To set the exposure, the photographer adjusts the settings on these controls.

**Controlling exposure.** Adjustable cameras have two controls that regulate exposure. One of these controls changes the speed of the shutter, and the other changes the size of the aperture.

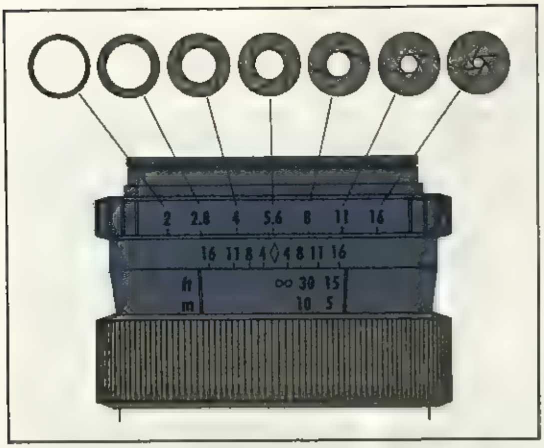
***Shutter speed*** is the amount of time the shutter remains open to let light expose the film. A slow shutter speed lets in a large amount of light, and a fast shutter speed admits only a little.

Most adjustable cameras have a range of shutter speeds from 1 second to $\frac{1}{1000}$ of a second. These speeds are represented by whole numbers on the standard scale of shutter speeds. The number 500 on the scale stands for $\frac{1}{500}$ of a second, 250 means $\frac{1}{250}$ of a second, and so on. Each number on the scale represents twice the speed of the preceding number or half the speed of the next number. At a setting of 250, for example, the shutter works twice as fast as at a setting of 125 and half as fast as at a setting of 500.

Fast shutter speeds enable photographers to take sharp pictures of moving subjects. Any movement of the subject will be recorded as a blur while the shutter remains open. At a setting of $\frac{1}{1000}$ of a second, the shutter is open for such a short time that even the motion of a speeding racing car appears to be "stopped." Most ordinary movement can be stopped at shutter-speed settings of $\frac{1}{60}$ or $\frac{1}{125}$.

***Aperture size*** is changed by a device called a *diaphragm,* which consists of a circle of overlapping metal leaves. The diaphragm expands to make the aperture larger and contracts to make it smaller. A large aperture admits more light than a small one.

The various sizes of an aperture are called *f-stops* or *f-numbers.* On adjustable cameras, the *f*-stops generally include 2, 2.8, 4, 5.6, 8, 11, and 16. The smaller the number, the larger the size of the aperture. Like the shutter speeds, each *f*-stop lets in either twice as much light




**Aperture size** is measured in *f-stops,* which may range from 2 to 16. These numbers appear on the aperture-setting ring of most cameras. The higher the *f*-stop, the smaller the aperture.

as the preceding setting or half as much light as the next higher setting. For example, if you *open up* the setting from *f*/11 to *f*/8, the aperture admits twice as much light into the camera. If you *stop down* the setting from *f*/11 to *f*/16, the aperture lets half as much light into the camera.

Changes in the size of the aperture affect the overall sharpness of the picture. As the aperture becomes smaller, the area of sharpness in front of and behind the subject becomes larger. This area of sharpness is called *depth of field.* It extends from the nearest part of the subject area in focus to the farthest part in focus. A small aperture, such as *f*/11 or *f*/16, creates great depth of field. As you open up the aperture, the area in focus becomes shallower. At *f*/4 or *f*/2, the subject will be in focus, but objects in the foreground and background may be blurred.

**Setting the exposure.** The proper exposure for a picture depends chiefly on (1) the lighting, (2) the subject, and (3) the desired depth of field. Each of these factors may require an adjustment in shutter speed or aperture size. You must choose a combination of settings that will meet all the requirements.

The amount of light in a scene affects both shutter speed and aperture size. On a cloudy day, you should reduce the shutter speed and increase the *f*-stop. On a sunny day, you should use settings for a fast shutter and a small aperture. Certain types of artificial lighting have special requirements for exposure.

The type of subject to be photographed may require an adjustment in the shutter speed, and depth of field may determine the aperture size. If the subject is moving, you must increase the shutter speed to prevent blurring. If you want a large area of the picture to be in sharp focus, you should choose a small aperture to provide greater depth of field.

If you adjust either the shutter speed or the aperture size, you must also adjust the other. A fast shutter speed stops the action, but it also reduces the amount of light reaching the film. To make up for this reduction in light, you should increase the *f*-stop. Similarly, a small aperture increases depth of field but reduces the amount of incoming light. Therefore, you should change to a slower shutter speed.

Suppose you want to photograph some squirrels on a sunny day. A suitable exposure for this type of lighting might be a shutter speed of 1/60 and an aperture of *f*/11. If the squirrels are moving, you might decide to increase the shutter speed to 1/125. This speed is twice as fast as 1/60, and so half as much light will reach the film. You should make the aperture twice as large by setting it at *f*/8. In the same way, if you change the shutter speed to 1/250—four times as fast—you should change the *f*-stop to *f*/5.6—four times as large.

You may want the photograph to include some acorns on the ground in front of the squirrels, and also the trees in the background. You can increase depth of field by reducing the size of the aperture. At a setting of *f*/16, the film will receive half as much light as it did at *f*/11. You should also change the shutter to the next slowest speed, so that the film will be exposed for twice as long.

### Controlling depth of field

Depth of field is the area of sharpness in front of and behind the subject of a photo. The size of this area can be controlled by adjusting the aperture setting on a camera. A wide aperture produces shallow depth of field, and a small one creates great depth of field.

**At f/2,** depth of field is shallow. It extends only a short distance from a subject in focus. If the figure in front or back is sharp, the others are blurred.

**At f/16,** depth of field is great. All figures are sharp.

There are four main types of photographic equipment. They are (1) cameras, (2) film, (3) lighting equipment, and (4) filters.

### Cameras

Nearly all cameras have the same basic design, which includes an aperture, a shutter, a viewfinder, and a film advance. However, cameras differ widely in such features as adjustability and the type of film used. The simplest cameras, called *fixed-focus cameras,* have a nonadjustable lens and only one or two shutter speeds. The majority of these cameras use cartridges of 110-sized film. Professional cameras, including *view cameras* and *studio cameras,* have many adjustable parts. Most such cameras use large sheets of film. See **Camera.**

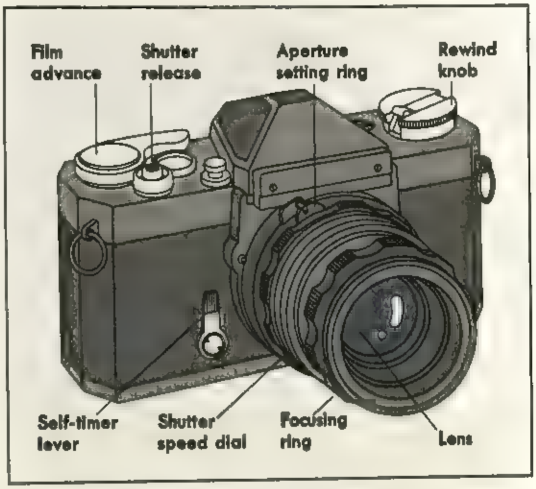
Cameras can be classified in several ways. One of the most widely used classifications is based on the type of viewing system. The principal types of viewing systems are the (1) rangefinder, (2) single-lens reflex, and (3) twin-lens reflex.

**Rangefinder cameras** have a viewing system that is separate from the lens. On most of these cameras, the viewfinder is a small window to the left of the lens. An angled mirror behind the lens reflects a second image of the subject into the viewfinder. To focus, a person looks through the viewfinder and adjusts the focusing mechanism until the two images come together.

The focused image in the viewfinder differs from the image on the film. This difference is called *parallax error.* To help correct for parallax error, the viewfinder on most rangefinder cameras has lines that frame the subject area "seen" by the lens.

The majority of rangefinder cameras are lightweight and relatively inexpensive. They use film that measures 35 millimetres wide.

**Single-lens reflex cameras** enable a photographer to look at a subject directly through the lens. A mirror mechanism between the lens and the film reflects the image onto a viewing screen. When the shutter release button is pressed, the mirror rises out of the way so that the light exposes the film. Thus, the photographer sees the image almost exactly as it is recorded on the film, and parallax error is avoided.




**A single-lens reflex camera,** or *SLR camera,* lets a photographer view subjects directly through the lens. Most SLR models have controls for focusing, aperture size, and shutter speed.

Most single-lens reflex cameras use 35-millimetre film and are heavier and more expensive than rangefinder models. In addition to avoiding parallax error, single-lens reflex cameras have the advantage of a wide variety of interchangeable lenses. The standard lens of these cameras can be replaced by lenses that change the size and depth relationships of objects in a scene. Such lenses include *wide-angle lenses, telephoto lenses, macro lenses,* and *zoom lenses.*

A wide-angle lens provides a wider view of a scene than a standard lens does. It is used for large scenes and in locations where the photographer cannot move back far enough to photograph the entire scene. A telephoto

**Some types of camera lenses**

The standard lens on many cameras can be replaced by specialized lenses, such as a *wide-angle lens* or a *telephoto lens.* A wide-angle lens provides a wider view of a scene but makes objects appear smaller and farther away. A telephoto lens makes the subject seem larger and closer.

**View with standard lens**

**View with wide-angle lens**

**View with telephoto lens**

lens makes objects appear larger and closer. It enables photographers to take detailed pictures of distant subjects. A macro lens, which is used in extreme close-up photography, focuses on subjects from a short distance. A zoom lens combines many features of standard, wide-angle, and telephoto lenses.

**Twin-lens reflex cameras** have their viewing lens directly above the picture-taking lens. The image in the viewing lens is reflected onto a screen at the top of the camera. A person holds the camera at waist- or chest-level and looks down at the viewing screen.

A twin-lens reflex camera has several advantages. Its viewing screen is much larger and clearer than those of eye-level cameras. Most twin-lens reflex models use film that produces negatives measuring 5.7 by 5.7 centimetres. However, these cameras are subject to parallax error and are heavier than the majority of single-lens reflex cameras. Also, most twin-lens reflex cameras do not have interchangeable lenses.

### Film

There are three main kinds of photographic film, based on the type of pictures produced. Black-and-white prints are made from *black-and-white negative film,* colour prints from *colour negative film,* and colour slides from *colour reversal film.* Film of each type is available with different characteristics that affect the overall quality of photographs. The most important of these characteristics include (1) speed, (2) graininess, (3) colour sensitivity, and (4) colour balance.

**Speed** is the amount of time required for the film to react to light. The speed of a film determines how much exposure is needed to record an image of the subject. A fast film reacts quickly to light and needs little exposure. This type of film is useful for scenes that have dim light or involve fast action. A medium-speed film requires moderate exposure and is suitable for average conditions of light and movement. A slow film needs much exposure and should be used for stationary subjects in a brightly lighted scene.

The principal systems of measuring film speed are the *DIN system,* used chiefly in Western Europe, and the international *ASA* and *ISO* systems. ASA stands for the American Standards Association, and ISO stands for the International Standards Organization. The higher the ASA or ISO number, the faster the speed of the film. Films that have numbers of 200 or higher are generally considered fast. Medium-speed films have numbers ranging from 80 to 125, and slow films are numbered lower than 80.

**Graininess** is the speckled or hazy appearance of some photographs. It is caused by clumps of silver grains on the film. The degree of graininess depends on the speed of the film. A fast film is more sensitive to light than other films are because its emulsion contains larger grains of silver salts. The fastest films produce the grainiest pictures. Medium-speed films and slow films produce little or no graininess in standard-sized prints, though some graininess may appear in enlargements.

**Colour sensitivity** is a characteristic of black-and-white film. It refers to the film's ability to record differences in colour. On the basis of colour sensitivity, black-and-white films are classified into several types, including *panchromatic film* and *orthochromatic film.* Panchromatic film, the most widely used type, is sensitive to all visible colours. Orthochromatic film records all colours except red. It is used chiefly by commercial artists to copy designs that have few colours.

**Colour balance** applies only to colour film. Such film is sensitive to all colours, including those of different kinds of light. The human eye sees light from nearly all sources as white. However, colour film records light from light bulbs as reddish, light from fluorescent bulbs as blue-green, and daylight as slightly blue. Variations in the emulsions of different types of colour film make the film less sensitive to certain colours. These variations balance the colour of light recorded on the film so that the colours in the photograph appear natural. Most colour film is balanced either for daylight or for specific types of artificial light.

### Lighting equipment

Lighting equipment can be divided into two basic categories according to function. *Exposure meters,* which make up the first category, measure the amount of light available for photography. *Artificial lighting devices,* the second category, provide any additional light needed to take a picture.

**Exposure meters,** also called *light meters,* help determine the correct exposure. Exposure meters are held in the hand or are built into a camera. Handheld meters record the light in a scene and indicate the camera settings for the proper exposure. Built-in meters measure the light that strikes the lens of the camera. Light readings appear on a scale on the viewing screen. In some cameras equipped with exposure meters, the shutter speed and aperture size are automatically adjusted to the amount of light available.

Exposure meters are classified according to the way they measure light. They include (1) reflected light meters and (2) incident light meters. Many handheld instruments can be used as both types of meters. Most built-in meters are reflected light meters.

*Reflected light meters* measure the light reflected from a scene toward the camera. Various areas in the scene reflect different amounts of light. Most built-in meters show the average amount of light reflected from all the areas. To measure reflected light with a handheld meter, the meter should be aimed at the main part of the scene. If there are strong contrasts in light and shadow, separate readings of the brightest and darkest areas should be taken and then averaged.

*Incident light meters* measure the light falling on a subject. When measuring this kind of light, the photographer should stand near the subject and point the meter toward the spot where the photo will be taken.

**Artificial lighting devices.** The most widely used sources of artificial lighting are (1) flashbulbs and (2) electronic flash. Both flash systems provide a short burst of light. Many professional photographers use lighting devices called *photoflood lamps,* which can provide continuous light for several hours.

Most cameras have a built-in device called a *flash synchronizer.* A flash synchronizer coordinates the flash

system with the shutter, so that the greatest brightness of the flash occurs at the instant the shutter reaches its full opening. On many cameras, the flash synchronizer works for flashbulbs at a shutter setting of *M* and for electronic flash at a setting of *X*.

*Flashbulbs* are powered by batteries or are activated by a device on the camera. A flashbulb contains a fine wire filament that spans two metal prongs called the *primer*. The filament ignites magnesium wire which creates the flash when an electric current passes through the primer. Each flashbulb supplies one burst of light. Flashbulbs differ widely in size and intensity. Most camera manuals specify the type to use.

*Electronic flash units* operate on batteries or on electricity from an outlet. They contain an *ionized* (electrically charged) gas inside a sealed tube. The gas emits a burst of bright light when an electric current is passed through it. Electronic flash units can fire thousands of flashes. Each flash provides as much light as a flashbulb but lasts a much shorter time. Electronic flash equipment ranges from small flash guns that fit onto the top of a camera to large studio units. Electronic flash units are more expensive than most flashbulb units but cost less per flash.

Some cameras have a built-in electronic flash. A warning light alerts the photographer if the lighting is too dim and a flash is required. Often it is a good idea to use a flash to reduce sharp contrasts caused by shadows in bright sunlight.

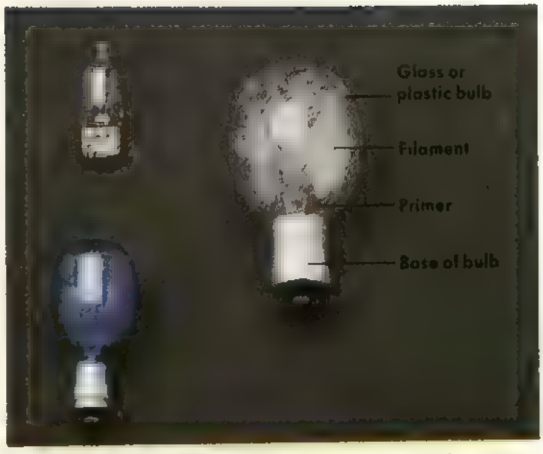
The exposure time for flash photographs depends on the distance of the subject and on the power of the flash unit. For flash photographs to be correctly exposed, you should set the aperture of your camera lens to the appropriate value shown in a table in the instruction sheet that comes with the flash unit. The table gives the aperture required for different distances and different speeds of film. Many flash units are equipped with a dial that enables rapid determination of the correct exposure. When you have selected the film speed and the camera-to-subject distance, a third dial will indicate the required aperture.

Scientists use high-speed flash units to produce very short exposure photographs of fast-moving objects, such as the wings of a flying insect. Xenon flash tubes, for example, can produce flashes of a few *nanoseconds* (thousand millionths of a second).

### Filters

A photographic filter is a disc of coloured, plasticlike gelatin or coloured glass in a holder. The holder fits over the lens of specific types of cameras. Filters screen out haze and glare or increase the contrast among tones in a picture. Nearly all filters hold back some light from the film. Therefore, when using a filter on most cameras, you must increase the exposure by the *filter factor* listed in the instructions provided with the film.

The most widely used filters include *ultraviolet filters, polarizing filters,* and *colour filters.* An ultraviolet filter reduces haze. It is useful for photographing distant subjects and for taking pictures at high altitudes. A polarizing filter screens out glare from shiny surfaces, such as water and glass. A colour filter increases the contrast in




**Flashbulbs** are made in many shapes and sizes. An electric current from a camera travels through the primer of the bulb and ignites the filament, creating a flash.

**Flashcubes and flashbars** contain several individual bulbs. A flashcube, *upper left*, has 4 bulbs, and flashbars, *right and lower left*, have multiple bulbs. Each bulb can be used only once.

**Electronic flash units** can be attached to a camera or held separately. They contain ionized gas in a glass tube. Electric current makes the gas glow. These units can be used repeatedly.

black-and-white photographs. It lets light of its own colour pass through the lens to the film but holds back certain other colours. As a result, objects that are the same colour as the filter appear light in the picture, and the blocked colours are dark. Suppose you use a red filter when taking a black-and-white photograph of an apple tree. The apples will look light grey, and the leaves and the sky will be dark grey or black. With a green filter, the leaves would appear lighter than the apples and the sky.

## *Developing and printing*

After the picture has been taken, the latent image on the film cannot be seen. The image becomes visible through the process of developing the film into a negative. The negative shows the reverse of the subject's light and dark areas. During printing, the image on the film is transferred onto paper, and the original colours or tones of the subject are restored.

Most amateur photographers have their film processed in commercial laboratories. However, an increasing number of photographers develop and print their own pictures. By processing the film themselves, they can change the size, composition, contrast, and other features of the photographs.

Black-and-white film and colour film are developed and printed in much the same way. However, the processing of colour film requires a few extra steps and some additional materials. Most types of film are removed from the camera and processed in a darkroom or a photographic laboratory. Instant film produces photographs directly from the camera.

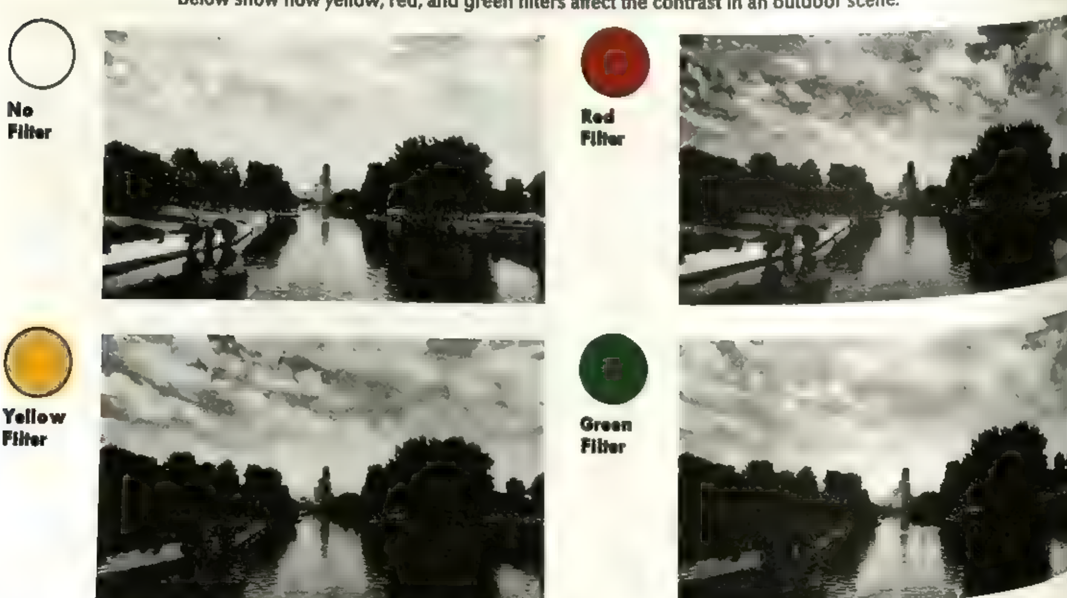
**Developing black-and-white film** requires two or more chemical solutions, several pieces of equipment, and running water. The chemical solutions should be stored in amber-coloured bottles made of polyethylene plastic, which resists chemicals and keeps light from harming the solutions. Each bottle should be clearly labelled with the name of its contents. Undeveloped film must not be exposed to light, and so a completely dark room or a lightproof *changing bag* are also needed.

The developing process has five basic steps. First, a chemical called a *developer* converts the exposed silver salts on the film's emulsion into metallic silver. The action of the developer is then stopped either by water or by a chemical solution known as a *stop bath.* In the third step, a chemical called a *fixer,* or *hypo,* dissolves the unexposed silver salts so they can be washed away. The fixer also contains a special hardening agent that makes the emulsion resistant to scratches. Next, the film is washed to remove the unexposed salts and the remaining chemicals. In the final step, the film is dried. The developed film is now a negative on which a visible, permanent image has been recorded.

To process film yourself, first darken the room or use a changing bag and remove the film from its spool. Then wind the film onto a reel that fits inside a lightproof *developing tank* designed so that liquids can be poured into or out of it without removing the lid. After the film is in the developing tank, you can work on it in the light.

Different types of developers and fixers are used for various kinds of film. The instructions provided with the film specify the type of solutions to use and the correct temperatures and times for the best results. Tempera-

**Colour filters** Colour filters are used chiefly to increase the contrast in black-and-white photographs. Each filter lightens the parts of a scene in its own colour and darkens those in other colours. The pictures below show how yellow, red, and green filters affect the contrast in an outdoor scene.



ture is particularly important for the developer. Negatives will be overdeveloped if the developer is too warm, or underdeveloped if it is too cold. To ensure proper development, each operation should be timed exactly.

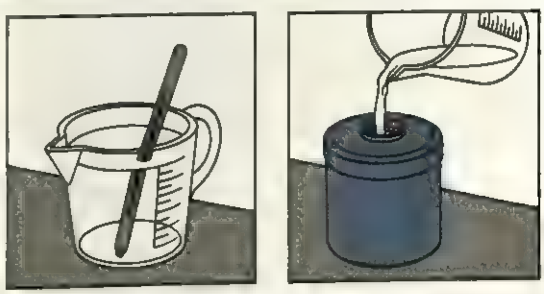
After the developer has been heated or cooled to the correct temperature, pour the chemical into the developing tank. Then *agitate* the tank for 30 seconds. To agitate the tank, repeatedly turn it upside down and back again in a steady movement. Agitation keeps a fresh supply of the developer in contact with the film so that the image on the film's surface develops evenly. Next, rap the tank on a hard surface to dislodge any air bubbles. Air bubbles can leave spots on the film. The film should be agitated at half-minute or one-minute intervals after the first 30 seconds.

When the developer has been in the developing tank for the specified time, pour it out and fill the tank with either running water or a stop-bath solution. Agitate the tank vigorously for about 10 seconds, and then drain it and pour in the fixer. After the fixing bath, which may last from 2 to 10 minutes, rinse the film with water or a special washing agent. Such an agent reduces the washing time from about 20 minutes to about 5 minutes. The film should then be treated with a wetting agent to remove any water spots.

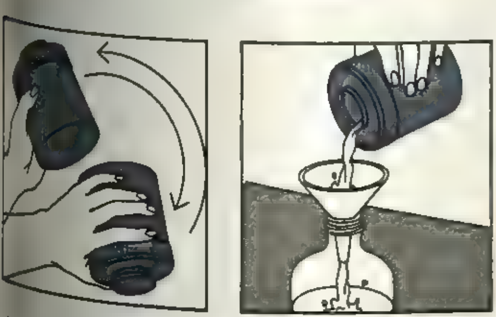

**Equipment for developing and printing** includes the items shown above. These processes also require completely dark surroundings and running water.

**How to develop film** To develop film, you need three main chemical solutions. The *developer* converts the exposed silver salts on the film into metallic silver. The *stop bath* halts the action of the developer. The *fixer,* also called *hypo,* dissolves the unexposed silver salts so they can be washed away.

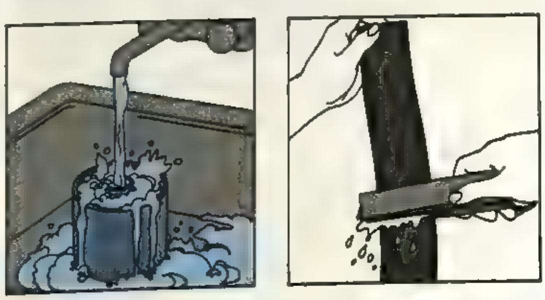
**Wind the film** onto the reel of the developing tank. Then place the reel in the tank and close the lid. You must work in total darkness until the film is inside the covered tank.



**Measure the developer** and bring it to the correct temperature, as specified in the instructions that come with the film. Next, pour the liquid into the tank and begin to time the process.



**Agitate the tank** at regular intervals during development. When the developing time is up, pour out the developer and add the stop bath. Then drain the tank and pour in the fixer.



**Rinse the film** with running water or a washing agent. Unwind the film from the reel of the tank and remove excess water with a squeegee. Finally, hang the film to dry in a dustfree area.

### How to judge a negative

Negatives should have good contrast among tones, plus detail in both highlight and shadow areas. If a negative is mostly dark and lacks detail in the highlight areas, it may be *overexposed.* A negative that has harsh highlights and few details in the shadow areas is probably *underexposed.*

**Normal negative** **Overexposed negative** **Underexposed negative**

To dry the film, unwind it from the reel in the developing tank and hang it in a dust-free area. A clip or a clothespeg should be attached to the lower end of the film to prevent the film from curling. As soon as the film has dried completely, cut it into strips about 15 centimetres long. Store the strips in film envelopes in a clean, dry place. Negatives can easily be scratched or bent, and so you should handle them only by the edges.

**Printing black-and-white photographs** is a process similar to making negatives. Printing paper is coated with an emulsion containing silver salts. During the printing process, light exposes the salts and forms a latent image on the printing paper. The paper must be developed before it can produce the visible image that will appear in the finished print.

To develop the printing paper, repeat the steps used in developing film. However, the paper is generally placed in open printing trays rather than in a developing tank, and different chemicals are used. To protect the latent image, you should work under a *safelight.* This kind of light illuminates the work area but does not expose the printing paper.

There are two principal methods of printing black-and-white photographs, *contact printing* and *projection printing.* Each process requires special equipment and produces a different type of print.

***Contact printing*** is the simplest method of printing photographs. To make a contact print, place the strips of negatives on a sheet of printing paper and cover them with a piece of glass. You can use a *printing frame* or a *printing box* to hold the negatives and paper in place. Shine a light through the glass for a few seconds, then remove the paper and develop it. If the print turns out too dark, repeat the process with a shorter exposure time. If the print is too light, use a longer exposure.

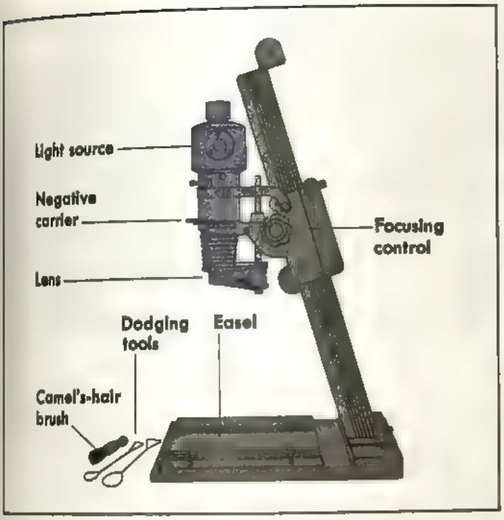
Contact printing is a quick, inexpensive way to preview photographs before making the final prints. Contact prints are the same size as the negatives, and so you can print an entire roll of film in one operation. For example, a 36-exposure roll of 35-millimetre film can be contact printed on a sheet of paper that measures 20-by-25 centimetres.

***Projection printing,*** or ***enlarging,*** produces photographs that are larger than their negatives. In projection printing, the negative is placed in a device called an *enlarger.* The enlarger projects the negative image onto printing paper in much the same way as a slide projector throws an image onto a screen. The image on the printing paper is larger than that on the negative. The size of this projected image depends on the distance between the negative and the paper. The greater the distance, the larger the image.

Enlargers have three basic parts, the *head,* the *baseboard,* and a rigid column that supports the head and is connected to the baseboard. The head contains a lens, a carrier for the negative, and a source of light. Like many cameras, the enlarger head also has a focusing control and an adjustable aperture. An easel on the baseboard holds the printing paper. During the enlarging process, the lens focuses the negative image on the printing paper, and light from the light source passes through the negative and exposes the paper.

The head of an enlarger can be raised or lowered to change the size of the image on the printing paper. This enables you to change the composition of the picture as well as enlarge the size of prints. By making the image larger than the intended print, you can crop undesirable areas and reposition the elements of the picture.

Before using an enlarger, you should clean the negative carefully with a camel's-hair brush or an aerosol device. Particles of dust on a negative may show up as white spots on the finished prints. Place the negative in the carrier, turn on the enlarger light, and focus the image on a piece of plain white paper or cardboard in the easel. Next, adjust the aperture. For most prints, you should at first set the aperture at a medium *f*-stop, such as *f*/8. After the image has been focused and framed, turn off the enlarger light and the light in the work area, and turn on the safelight. Then insert a sheet of printing paper into the easel.




**An enlarger,** the basic instrument used in projection printing, projects the image in a negative onto printing paper. Light passes through the negative and exposes the paper in the easel.

The next step in the enlarging process is to determine the proper exposure time for the print by making *test strips.* Test strips are portions of a print that have been exposed for different amounts of time, generally ranging from 10 seconds to 50 seconds. After the test strips have been developed, you can decide which of the exposure times produced the best result. If all the test strips appear too light, open up the enlarger lens by two *f*-stops and make another set of strips. If the test strips are all too dark, close down the lens by two *f*-stops and repeat the procedure.

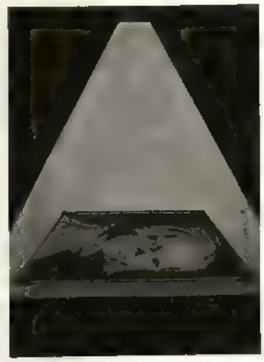
If only one area of the print turns out too light, you can darken the area by *burning in* the print. In this technique, a piece of cardboard with a small hole in it is held over the area to be darkened. Light passes through the hole in the cardboard and exposes the area, which then becomes darker. If an area of the print is too dark, it can be lightened by means of *dodging.* This procedure involves covering the dark area with a special dodging tool or a cardboard disk during part of the exposure time. The covered area will appear lighter in relation to the fully exposed parts of the print.

Overall contrast in prints is determined largely by the type of printing paper used. Printing papers are graded by number from 0 to 6 according to the degree of contrast produced in the prints. The higher the number, the greater the degree of contrast. A high-contrast or *hard* paper, such as No. 4, is generally used to print a normal range of tones from a negative that has little contrast. Paper No. 1, a low-contrast or *soft* paper, may be used to reduce the contrast in a negative that has extreme light and dark tones. Some papers contain different grades of contrast. These *multicontrast papers* require different colours of light to produce each grade. You can change the colour of the enlarger light by placing a coloured printing filter over the lens.

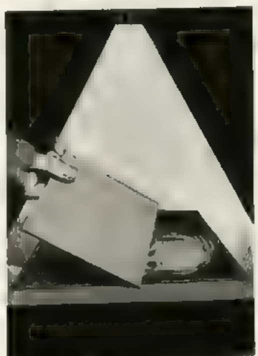
In addition to contrast, printing papers for black and white photography differ in several characteristics that

## Techniques of projection printing

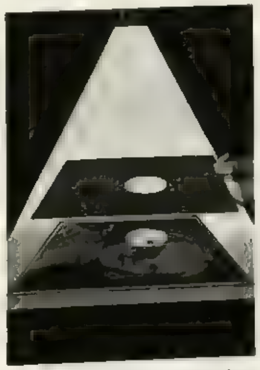
**Focusing.** Set the lens at the widest opening and place a piece of cardboard in the easel. Turn on the enlarger light and focus the image on the cardboard.



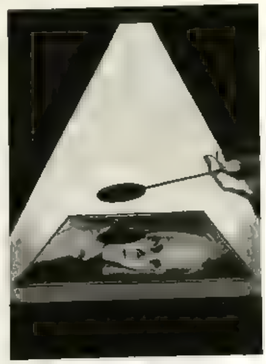
**Exposing.** Change the lens setting to *f*/8. Turn the enlarger light off and the safelight on. Replace the cardboard with printing paper and make the exposure.



**Making test strips** determines the correct exposure time. Cover all but about a fifth of the printing paper with cardboard, *above left.* Expose for 5 seconds. Expose four more strips for 5 seconds each. The developed paper, *above right,* shows exposures of 25, 20, 15, 10, and 5 seconds. Select the best time.



**Burning in** allows extra light to darken part of a print. Move the cardboard quickly in circles about halfway between the lens and the paper.



**Dodging** lightens part of a print by blocking light. Move the dodging tool in small circles so the edges blend into the rest of the print.

**How printing papers affect contrast**

Printing papers are graded from 0 to 6, according to the degree of contrast produced. A low-contrast paper, such as No. 1, shows few tones. A wide range of tones are produced by No. 2, a medium-contrast paper. A high-contrast paper, such as No. 4, prints photos with extreme contrast.

No. 1 paper

No. 2 paper

No. 4 paper

affect the appearance of prints. One of these characteristics is tone. In a photograph printed on *warm-toned paper,* the colour black is reproduced as brown. On *cold-toned paper,* black appears blue. Another feature of printing papers is surface, which ranges from *matte* (dull) to *glossy.*

**Developing colour film** involves the same basic procedures as black-and-white developing. However, the chemical processes in colour developing are much more complicated. To understand these processes, you need to know some of the basic principles of colour.

Colour depends chiefly on light. Although most light looks white to the eye, it is actually a mixture of three *primary colours*—blue, green, and red. Any colour can be produced by blending these three colours of light. See **Colour** (Mixing coloured lights).

Colour film contains three layers of emulsions. These emulsions are similar to the emulsion on black-and-white film. But in colour film, each of the emulsions is sensitive to only one of the primary colours of light. During exposure, the first emulsion reacts only to blue light, the second emulsion only to green light, and the third only to red light.

When colour film is exposed, light strikes the first emulsion and forms an image on the blue areas of the scene. The light then passes through the second emulsion, forming an image of the green areas. Finally, the light goes through the third emulsion and records an image of the red areas. Three latent images are thus recorded on the film.

The developing process changes colour film in two main ways. First, the developer converts the exposed silver salts on the emulsions into metallic silver. The silver image produced on each layer of emulsion represents the colour of the light—blue, green, or red—that exposed the emulsion.

Second, the developer activates a substance called a *coupler* in each emulsion. Couplers unite with chemicals in the developer to produce coloured dyes. The colours of the dyes are the *complements* (opposite colours) of the light that exposed the emulsions. Yellow is the complement of blue, and so a yellow dye forms in the first layer. In the second layer, the dye is *magenta* (purplish-red) because magenta is the complement of green. The dye in the third layer is *cyan* (bluish-green), the complement of red. Complementary colours are used as dyes because they reproduce the original colours of the subject when the film is processed into photographs.

Both colour reversal film, which produces slides, and colour negative film, which makes prints, record coloured images in the same way. However, different materials and slightly different procedures are used to develop each type of film.

*Colour reversal film* requires two different developers. The first developer changes the exposed silver salts on the film into metallic silver. The film is then re-exposed or treated with a chemical agent so that the remaining silver salts can be developed. The second developer activates the couplers in the emulsions, causing coloured dyes to form around the silver image in each emulsion layer. After the silver has been bleached out of the images, the images remain as transparent areas on the film. The developed film, called a *positive,* can be cut into separate pictures and mounted as slides.

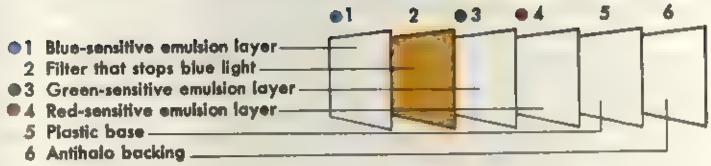
On a slide, each area of the subject is transparent in one of the emulsion layers. In each of the other two layers, the area has a complementary colour different from that of its original colour. For example, the image of a blue sky would be transparent in the first emulsion layer. The image would be magenta (the complement of green) in the second layer and cyan (the complement of red) in the third layer. When light passes through the slide, each dye acts as a filter on a primary colour. The magenta layer holds back green light, and the cyan layer holds back red light. As a result, only blue light passes through the transparent area of the slide, and the sky appears blue.

*Colour negative film* is treated with only one developer. The developer converts the exposed silver salts into metallic silver and activates the dye couplers at the same time. After the developing procedure, each area of the subject appears on a layer of emulsion in a colour complementary to the original colour. For example, a blue object would be recorded as a yellow image on the first emulsion layer, and a green one would appear as a magenta image on the second layer. The images are printed in the complementary colours of the negative, thus reproducing the original shades.

**Printing colour photographs** involves the same chemical processes as those used in developing colour film. Like colour film, colour printing paper has three layers of emulsions, each of which is sensitive to one of

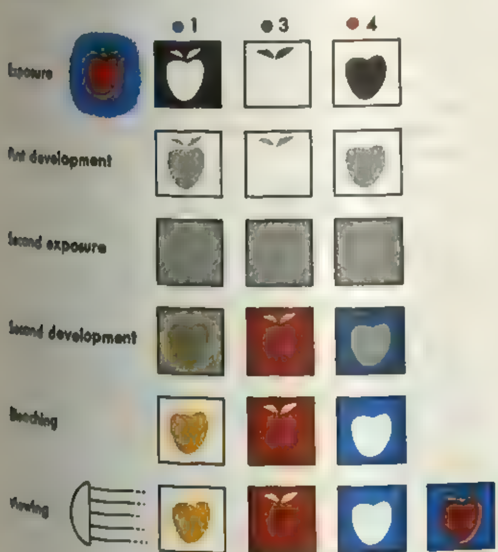
### How colour film works

Colour film consists of six layers: (1) an emulsion that records blue, (2) a yellow filter that absorbs excess blue light, (3) an emulsion that records green, (4) an emulsion that records red, (5) a plastic base that supports the emulsions, and (6) an *antihalo* backing that absorbs excess light.



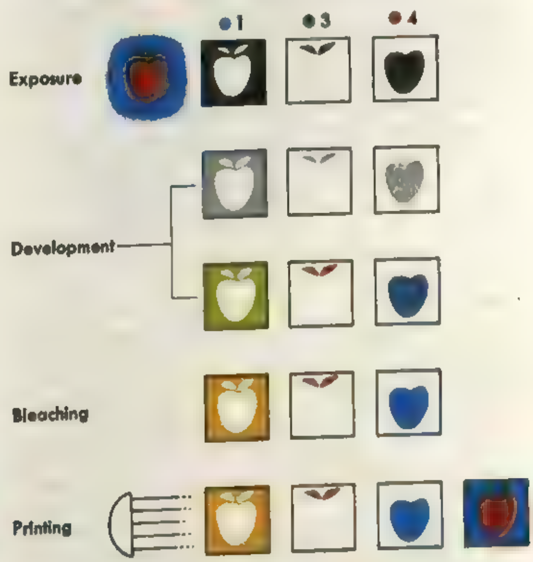

### How colour slides are made

Colour slides are made from colour reversal film. After exposure, the film contains images of the blue, green, and red areas of the subject. The film then goes through two development processes. The first development changes the exposed silver salts to metallic silver. A negative silver image forms in each layer of the film. Then the film is re-exposed so that the remaining silver salts can be developed. During the second development, coloured dyes form around the silver images on the film. The silver is then bleached out of each image, leaving transparent film in those areas. In the developed film, a yellow dye surrounds the image made by blue light. A *magenta* (purplish-red) dye surrounds the image made by green light. A *cyan* (bluish-green) dye surrounds the one formed by red light. When the film is made into a slide and projected, each dye holds back light of its complementary colour, and the original colours of the subject appear on the viewing screen.




### How colour prints are made

Colour prints are made from colour negative film. After exposure, the film contains images of the blue, green, and red areas of the subject. During development, the exposed silver salts produce a metallic silver image in each layer of the film. A coloured dye forms over each image. The silver is then bleached out, leaving only the dye. In the negative, a yellow dye covers the image made by blue light. A magenta dye covers the image made by green light. A cyan dye covers the one formed by red light. These colours are hard to see because the negative has an overall orange tint that improves the colour quality of prints. When the negative is printed, each dye holds back light of its complementary colour. The yellow dye absorbs blue light and lets red and green light pass through. The magenta dye absorbs green and lets blue and red through. The cyan dye absorbs red and lets blue and green go through. In this way, the original colours of the subject appear in the print.





Colour slide


Negative film


Colour print

the primary colours of light. During printing, the yellow, magenta, and cyan dyes on the negative hold back light of their complementary colours—that is, each dye filters out one of the primary colours. Thus, the colours of light that expose the printing paper are the opposite of those that exposed the film. When the paper is developed, couplers in the emulsion layers form dyes that reproduce the colours of the subject.

Certain features of colour prints can be changed by some of the same techniques used in black-and-white printing—adjusting the exposure, cropping, burning in, and dodging. In addition, the *colour balance* of the prints can be adjusted by placing colour filters over the enlarger lens. These filters, which are tinted in various shades of yellow, magenta, and cyan, reduce the intensity of the corresponding primary colours in the print. If the blue tones in the print are too strong, for example, you should put a yellow filter on the enlarger lens and repeat the printing procedure.

Colour prints can be made from colour slides as well as from colour negatives. The same basic printing procedures are used in making slides and negatives. However, the effects of exposure are reversed with slides, which contain positive images. In printing from negatives, for example, a longer exposure makes a print darker. But in printing from slides, the same exposure time makes a print lighter. The effects of colour filters are also reversed in making prints from slides. Strong colours in such prints are balanced by using filters of the same colours rather than of complementary colours.

**Instant processing.** Instant film produces prints in from 15 seconds to 8 minutes, depending on the type of film. When the exposed film comes out of an instant camera, it is covered by a lightproof sheath. This sheath, which is either a sheet of paper or an *opaque* (nontransparent) layer of chemicals, serves as a kind of darkroom for the processing of the film. If the film has a paper sheath, the paper is peeled from the print after the specified developing time. If the film has a chemical sheath, the print is finished when the opaque layer turns completely transparent.

Instant prints are processed in much the same way as contact prints. The chief difference between the two procedures is that the negative and the positive of an instant print are developed at the same time rather than in separate stages.

Instant black-and-white film contains layers of negative and positive emulsions, with a packet of jellylike developing chemicals between the layers. After exposure, the film passes through a pair of steel rollers in the camera. The pressure of the rollers causes the packet to burst, releasing the developing chemicals. The chemicals immediately convert the exposed silver salts on the negative layer into metallic silver. Within a few seconds, the unexposed salts move to the positive layer. There, they are changed into silver, forming a positive image on the print.

Instant colour film has layers of coloured dyes in addition to negative and positive emulsions and a packet of developing chemicals. When the chemicals are released, they develop the silver salts and activate the coloured dyes at the same time. An image in colours complementary to those of the subject forms on the negative layer of emulsion. Then the image is transferred onto the positive emulsion layer, where the colours are reversed to the original ones.

## Making home movies

Many people enjoy making home movies. Two types of cameras are commonly used to make home movies—*movie* or *cine cameras* and *video cameras.* A movie camera records an image on a long, narrow strip of film. A video camera captures an image and converts it to electronic signals, which are stored on a magnetic tape called a *videotape.* A film projector is used to play back film for viewing. Videotape is played back by a videotape recorder attached to a television set.

Most home-movie cameras shoot 18 to 24 frames (pictures) per second and use 8-millimetre film called *super 8.* Super 8 cartridges contain $3\frac{1}{3}$ or $2\frac{1}{2}$ minutes of film, depending on the camera's shooting speed.

Video cameras record onto videotape cassettes, which come in several different formats, including VHS, Beta, and 8-millimetre. Video cassettes can hold up to eight hours of home movies, depending on the type used. Some video cameras must be attached to a videotape recorder for taping. Others, called *camcorders,* consist of a camera and videotape recorder in one unit.

Today, video cameras far outsell movie cameras. One reason for their popularity is that videotape, unlike film, does not require developing and can be viewed immediately. Another reason is that a videotape can record for several hours, but a reel of film runs only a few minutes. In addition, most people find it easier to play back a videotape on a videotape recorder than to set up a film projector and a screen. Many people have had their reels of home movies copied onto videotape.

Most movie cameras and video cameras have an electric eye that automatically adjusts the lens aperture to the intensity of the light being used. Most also include a filter that corrects for the colour of the light. Another common feature is a *zoom lens,* which can adjust the image from a long-range view to a close-up view while the camera is running. Many video cameras have *autofocus,* which enables them to focus on a subject automatically.

The basic principles of still photography apply to home movies. For example, such factors as composition, light, and focusing must be considered. A film or video has the additional feature of continuous action, and so the order of scenes to be shot should be planned. Many home movies also have sound, which must be coordinated with the action. Many people also edit their work. Editing may involve rearranging some scenes and trimming or eliminating others.

For a discussion of movie cameras and film projectors, see the *World Book* article on **Film industry** (How films work). For a discussion of video cameras and videotape recorders, see the *World Book* articles on **Video camera** and **Videotape recorder**.

**Planning** is essential to making a movie, regardless of its subject. Before shooting begins, the camera operator should plan the *subject sequencing* and the *visual sequencing* of the scenes.

Subject sequencing determines the order and content of the scenes to be shot. It is based on the story or theme of the film. The scenes should both advance the action and establish the mood of the film. For example, a film about a birthday party might begin with relatively long scenes showing the preparations for the party. It might move on to shorter, more active scenes as the excitement builds and the party begins. A film about a historic event might have short scenes at the beginning to introduce the characters and the setting. Longer, narrative scenes would appear later.

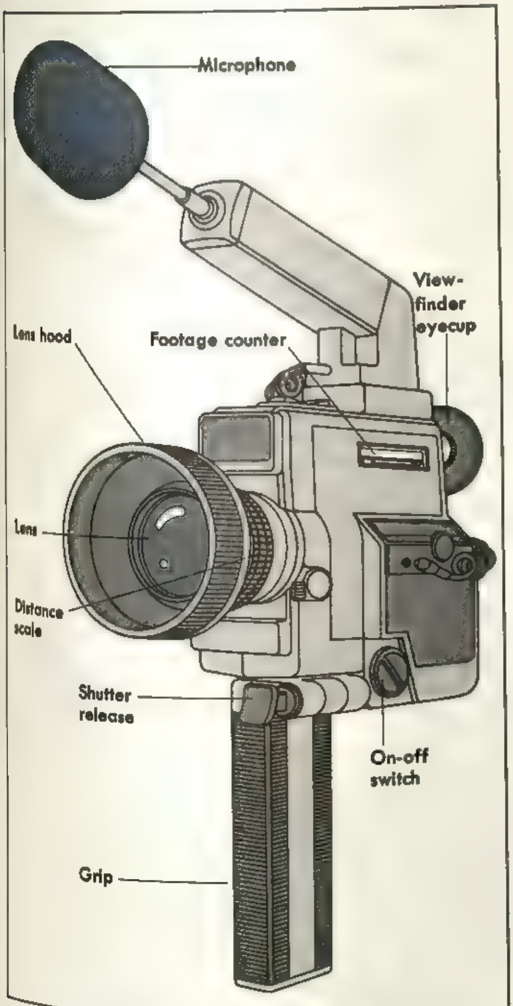
Visual sequencing controls the way in which the scenes are to be shot. At the simplest level, the visual sequence should be logical. For example, subjects that leave a scene in one direction should reenter from the same direction. Visual sequencing should also reinforce the subject matter of the film. To show the confusion of city traffic, for example, the filmmaker might quickly shift the camera from one angle to another while shooting the moving vehicles.

**Shooting a home movie.** The camera should be kept as steady as possible during shooting because any vibration would be greatly magnified when viewed by an audience. Many filmmakers steady the camera by mounting it on a tripod. The camera may be moved to create certain visual effects. The two basic ways in which it can be moved are called *zooming* and *panning.*

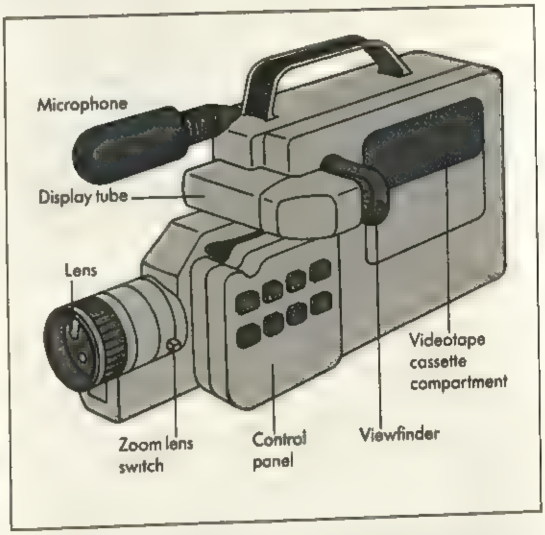
Zooming involves adjusting the zoom lens to change the size and depth relationships of the subjects in a scene. A filmmaker zooms in on a scene for three kinds of shots. These are a *long shot,* which covers an entire scene; a *medium shot,* which takes in part of the scene; or a *close-up shot* of a single character. Zooming thus directs the viewer's attention to various elements of a scene. This technique also enables the filmmaker to maintain the relative size of subjects as their distance from the camera changes. The field of view can be widened if the subjects move closer to the camera or narrowed if they move away from it.

Panning may be used when shooting an extremely wide field of view and when following a subject moving across the scene. In panning, the camera is rotated on its axis in much the same way as you turn your head to watch a passing car.

In addition to zooming and panning, some movie cameras enable filmmakers to vary the speed of filming. This enables the action of the film to appear slower or faster than normal. An illusion of slow motion can be created by increasing the number of frames shot per second. By using this technique, each movement will take up more frames than it would at the usual filming




**A sound-film camera** shoots pictures and records sound at the same time. The model shown above takes drop-in cartridges of super 8 film and is held by hand.




**A camcorder** is a portable movie camera with a built-in videotape recorder. It converts images and sound into electronic signals, which it stores on a videotape cassette. The videotape can be replayed immediately after recording.

speed. When the film is shown, the frames advance at the regular rate, making their motion appear extremely slow. In a similar way, the action in a film can be speeded up by shooting fewer frames per second.

A technique called *time-lapse photography* can be used to film or tape an event, such as the blossoming of a flower, that takes place over a long period. In time-lapse photography, the camera is kept stationary and is set to expose only one frame of film or a second or less of tape at a time. The pictures are taken at intervals ranging from one per minute to once a day or longer. When the film is shown, the action appears to take place during the running time of the film or tape.

**Recording sound.** Some movie cameras can record sound directly on film. These cameras include a microphone and use film that has a magnetic strip on one side. During filming, the microphone picks up sound and the camera records it on the film's magnetic strip.

A filmmaker can record sound separately on a tape recorder when using a camera that does not include sound equipment. The sound is then recorded on a magnetic strip and added to the film. It also can be played back on the recorder while the film is being shown. Tape recorders may be used to provide background music, narration, and special sound effects.

**Editing** improves any film, no matter how carefully it was planned and shot. Filmmakers begin the editing process by examining the film scene by scene. They carefully look for places to cut or add material. For example, a scene might run too long or it might be more effective in another place in the film.

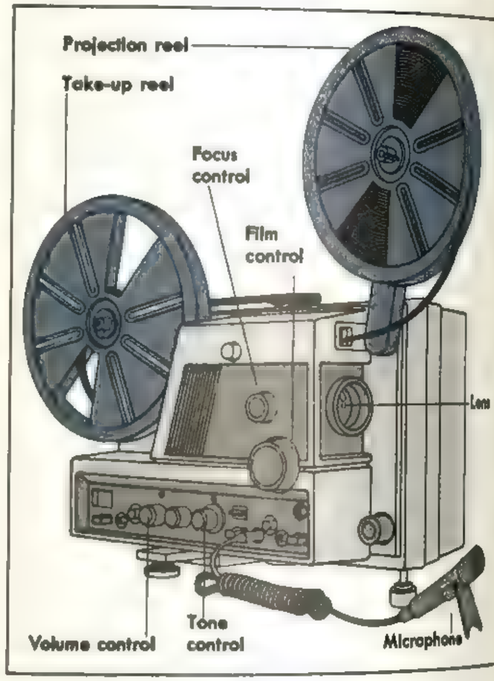
Using a machine called a *film editor,* the filmmaker can examine a film on a viewing screen, then mark any segments that should be eliminated or rearranged. After cutting out these segments, the filmmaker can *splice* (join) the cut ends with tape or glue.

A video camera allows filmmakers to edit while taping. If they do not like a scene, they can rewind the videotape and record a new scene over the old one. A video editing device can also be used. This device connects one videocassette recorder to another or to a camcorder. It allows a filmmaker to copy segments from one tape onto another in any order.

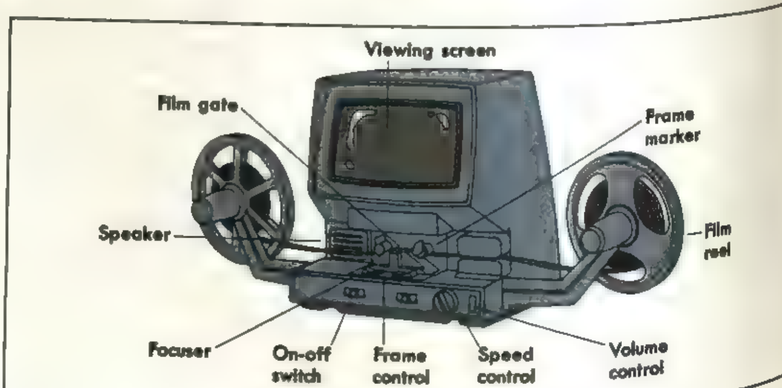
**Viewing home movies.** Showing a film requires a film projector, a darkened room, and a flat, white surface. Cartridge projectors and projectors with automatic film-threading devices are the easiest kinds to operate. Sound projectors are used for sound films. Films can be projected on to a wall or even on to an unwrinkled bedsheet if necessary. However, they look much brighter on a viewing screen because the surface of the screen intensifies the light from the projector.

Showing a videotape requires a videotape recorder and a television set. For more information, see the *World Book* article **Videotape recorder**. Some camcorders do not require a separate videotape recorder to view the tape. These camcorders can be connected by cables to a television set.

**Sound-film projectors** may not only play back sound films, but also record sound. Such projectors enable filmmakers to add narration, background music, or special sound effects to a film after it has been shot.




**A film editor** is a machine that enables filmmakers to edit their films. While examining the film on a viewing screen, they mark any *frames* (pictures) that should be eliminated or rearranged. After cutting out these frames, the filmmakers *splice* (join together) the cut ends with special tape or glue.



**Early developments.** The ancient Greek philosopher Aristotle observed that light passing through a small hole in the wall of a room formed an upside-down image of an object. However, this characteristic of light was not used to construct a camera until about A.D. 1500, in Italy. The first crude camera, called a *camera obscura* (dark chamber), consisted of a huge box with a tiny opening in one side that admitted light. On the opposite side of the box, the light formed an inverted image of the scene outside. The camera obscura was large enough for a person to enter, and it was used chiefly by artists as a sketching aid. They traced the outline of the image formed inside the box and then coloured the picture. See **Camera obscura.**

A camera obscura could only project images onto a screen or a piece of paper. Scientists sought a way to make the images permanent. In 1727, a German physicist named Johann H. Schulze discovered that silver salts turn dark when exposed to light. About 50 years later, Carl Scheele, a Swedish chemist, showed that the changes caused in the salts by light could be made permanent by chemical treatment. However, these discoveries were not used for photography until the 1830's.

Meanwhile, a French inventor named Joseph Nicéphore Niépce found a way to produce a permanent image in a camera obscura. In 1826, he coated a metal plate with a light-sensitive chemical and then exposed the plate in the camera for about eight hours. The resulting picture, showing the view from Niépce's window, was the world's first photograph.

Niépce's technique was perfected during the 1830's by the French inventor Louis Daguerre. Daguerre exposed a sheet of silver-coated copper, developed the image with mercury vapor, and then "fixed" it with table salt. His pictures, called *daguerreotypes,* required a relatively short exposure of 15 to 30 seconds and produced sharp, detailed images. See **Daguerreotype.**

In 1839, the same year Daguerre patented his process, a British inventor named William H. Fox Talbot announced his invention of light-sensitive paper. This paper produced a negative from which positive prints

**The first photograph,** taken in 1826 by Joseph Nicéphore Niépce, a French physicist, shows a view from his window. He exposed a light-sensitive metal plate for about eight hours.

**The daguerreotype** was the first popular form of photography. It required a relatively short exposure. The earliest surviving daguerreotype, *above,* was made in 1837.

could be made. Fox Talbot's friend, the astronomer Sir John Herschel, called the invention *photography.* Herschel suggested the use of sodium thiosulphate (hypo) as a fixing agent. Both Daguerre and Fox Talbot then began using this chemical in their processes.

Fox Talbot's paper prints, which were called *talbotypes* or *calotypes,* did not contain images as sharp as those of daguerreotypes. But the negative-to-positive process of making photographs had two important advantages. It produced many prints from one exposure, and the pictures could be included in books, newspapers, and other printed materials. See **Talbotype.**

In addition to the new developing and printing processes, photography was greatly improved during the 1840's by the introduction of specialized lenses. A Hungarian mathematician named Josef M. Petzval designed two types of lenses, one for making portraits and the other for landscape pictures. The portrait lens admitted much more light than previous lenses had and so reduced the exposure time to a few minutes. The landscape lens produced sharper pictures of large areas than previously had been possible.

**The beginnings of modern photography.** During the second half of the 1800's, scientists further improved photographic processes and the design of cameras. These advances enabled photographers to experiment with the artistic possibilities of photography.

*Technical improvements.* In 1851, a British photographer named Frederick S. Archer introduced a photographic process that greatly reduced exposure time and improved the quality of prints. In Archer's process, a glass plate was coated with a mixture of silver salts and an emulsion made of a wet, sticky substance called *collodion.* After being exposed for a few seconds, the plate was developed into a negative and then treated with a fixing agent. The collodion had to remain moist during exposure and developing, and so a photographer had to process pictures immediately after taking them. Many photographers travelled in wagons that served as a darkroom and a developing laboratory.

The invention of the *dry-plate process* overcame the

inconvenience of the collodion method. In 1871, Richard L. Maddox, a British doctor, used an emulsion of gelatin to coat photographic plates. Unlike collodion, gelatin dried on a plate without harming the silver salts. By using dry plates, photographers did not have to process a picture immediately.

The use of gelatin also eliminated the necessity of keeping a camera motionless on a tripod during exposure. By the late 1870's, improvements in the gelatin emulsion had reduced exposure time to $\frac{1}{25}$ of a second or even less. Photographers could now take pictures while holding the camera in their hands.

In addition to giving photographers greater mobility and freedom, the introduction of the gelatin emulsion revolutionized the design of cameras. Earlier types of printing paper could only be contact printed, and, therefore, negatives had to be as large as the intended print. But photos on paper coated with gelatin could be made by projection printing. Photographers could enlarge such pictures during the printing process, and so the size of negatives could be reduced. Smaller negatives meant smaller cameras.

In 1888, George Eastman, an American dry-plate manufacturer, introduced the Kodak box camera. The Kodak was the first camera designed specifically for mass production and amateur use. It was lightweight, inexpensive, and easy to operate.

The Kodak system also eliminated the need for photographers to process their own pictures. The Kodak used a roll of gelatin-coated film that could record 100 round photographs. After a roll had been used, a person sent the camera with the film inside to one of Eastman's processing plants. The plant developed the film, made prints, and then returned the camera loaded with a new roll of film. The Kodak slogan declared: "You Press the Button, We Do the Rest."

***Artistic advances.*** During the 1850's and 1860's, many people began to experiment with the artistic possibilities of photography. One of the first to use a camera creatively was Gaspard Félix Tournachon, a French photographer who called himself Nadar. Nadar added a new element to portrait photography by emphasizing the pose and gestures characteristic of his subjects. However, his most famous achievement was the first aerial photograph, a view of Paris taken from a balloon.

Another pioneer in portrait photography was the British photographer Julia M. Cameron. She emphasized expressiveness over technical quality, and so many of her pictures were blurred or out of focus. But Cameron captured the personalities of her subjects, who included such famous persons as Sir John Herschel and the British naturalist Charles Darwin.

Landscapes and architecture were also popular subjects for early art photographers. During the 1850's and 1860's, a number of governments commissioned photographers to make visual records of important buildings and natural features in various countries. Photographs were taken of historical sites in Europe and the Middle East, the scenery of the American West, and many other major landmarks. Some of these pictures were remarkable not only for their technical excellence but also for the effort involved in taking them. In 1861, for example, two French photographers named Auguste and Louis Bisson withstood intense cold and avalanches to take pictures from the top of Mont Blanc in France. The brothers needed so much equipment that they took 25 porters up the mountain with them.

Some of the most dramatic photographs of the mid-1800's are battlefield scenes. The earliest surviving pictures of this type were taken by Roger Fenton, a British journalist covering the Crimean War (1853-1856). The photos of the American Civil War (1861-1865) made by Mathew Brady and his assistants rank among the finest war pictures of all time.

During the late 1800's, some photographers used their pictures to dramatize issues, rather than simply record events or create artistic effects. One such photographer was William H. Jackson, an American, who

**News photography** was born during the mid-1800's with the work of Mathew Brady of the United States and other photographers. Brady's pictures of the American Civil War captured both the horror of the battlefield and the humanity of the soldiers. Brady processed his photos by the *collodion method,* which required an enormous amount of equipment. His photographic van can be seen on the right of this picture.

**The Kodak camera,** invented in 1888 by the U.S. manufacturer George Eastman, made picture taking easy. This photo of him was taken with a Kodak identical with the one he is holding.

specialized in photographing the Far West of the United States. His pictures of the Yellowstone area helped persuade Congress to establish the world's first national park there.

Two other American photographers, Jacob A. Riis and Lewis W. Hine, took pictures that exposed social evils. In 1888, Riis's photographs of the slums of New York City shocked the public and helped bring about the abolition of one of the city's worst districts (see **Riis, Jacob A.**). Hine, a sociologist, documented the miserable working conditions of the poor. His pictures of children working in coal mines and dimly lit factories helped bring about the passage of child-labour laws. See **Child labour** (picture).

**The photographic revolution.** By the late 1800's, the development of photography was moving in two directions. The appearance of the Kodak and other inexpensive box cameras had led to a tremendous rise in the number of amateur photographers. Previously, photography had been limited to people who knew how to use complicated photographic equipment and could afford to buy it. Now, almost anyone could take a picture.

On the other hand, some photographers wanted photography to be considered a creative art in the tradition of drawing and painting. Many of these *pictorial photographers* tried to make their prints look like paintings. They used special printing techniques and paper to give their photographs a texture similar to that of painted canvases. Some photographers even coloured the images with paint. In 1902, Alfred Stieglitz, Edward Steichen, and a number of other American photographers formed a group to promote photography as an independent art form. This group, which was called the Photo-Secession, organized photographic exhibitions in the United States and loaned collections of photos to exhibitors in many other countries.

The idea that photographers should imitate painters was soon challenged. After about 1910, many photographers believed that unretouched photographs had a beauty and elegance unmatched by other works of art. Their ideal of "pure" photography influenced such later photographers as Edward Weston and Paul Strand of the United States.

During the 1920's and early 1930's, photography underwent dramatic changes as the result of two major developments. First, photographic equipment was revolutionized by the miniature 35-millimetre camera and artificial lighting. The Leica camera, introduced in 1924 in Germany, was small enough to fit in a pocket, but it produced clear, detailed photographs. Many photographers used the Leica to take *candid pictures,* in which people did not know they were being photographed. The electric flashbulb, introduced in 1929, and electronic flash, invented in 1931, greatly expanded the range of photographic subjects.

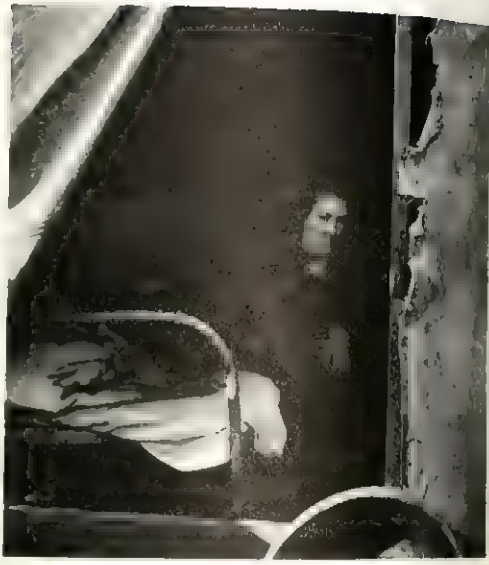
The second major development involved experimentation with new ways of composing pictures and viewing subjects. László Moholy-Nagy, a Hungarian, and Man Ray, an American, produced photographs without using a camera. They placed objects on a piece of printing paper and exposed the paper with a torch. Other photographers created abstract compositions with X-ray photographs and multiple exposures. The French photographer Henri Cartier-Bresson was one of the first to utilize the creative possibilities of the miniature camera.

**Expressive portraits** were a trademark of the influential American photographer Alfred Stieglitz. This picture shows the artist Georgia O'Keeffe, his wife, in front of one of her works.

He tried to capture people's gestures and feelings at "decisive moments" of their lives.

A technique called *documentary photography* developed in the 1930's. During the Great Depression, the U.S. Department of Agriculture hired photographers to survey conditions in rural areas of the United States. The outstanding photographers involved in this project included Walker Evans and Dorothea Lange. Their pictures portray the courage and suffering of the poverty-stricken farm families. At the same time, the appearance of illustrated news magazines in Europe and the United States created a demand for news photographs. Such photojournalists as Margaret Bourke-White and Robert Capa, both of the United States, vividly recorded some of the most important people and dramatic events of the period.

Other photographers of the 1930's and 1940's concentrated on ordinary subjects or natural scenery. Many pictures taken by Edward Weston and Paul Strand emphasize the textures and geometric shapes of everyday objects. Weston and Strand helped develop the technique of *straight photography,* which features sharply focused, detailed images. Another American photographer, Ansel Adams, specialized in landscapes, especially the mountains and deserts of the American West.



**Documentary photographs** may persuade as well as inform. The sensitive portraits of migrant farmworkers by U.S. photographer Dorothea Lange aroused public concern over their plight.

**Dramatic moments** dominate the work of the French photographer Henri Cartier-Bresson. The lively figures of the running girls above are balanced by the stately buildings and trees.

During the 1950's and 1960's, photographic styles became increasingly varied, particularly in the United States. The "street photography" of such photographers as Robert Frank and Garry Winogrand followed the tradition of documentary realism. Other photographers experimented with various printing techniques to achieve unusual effects. For example, Robert Heinecken produced imaginative photographs by making contact prints directly from the illustrated pages of magazines. Another major group of photographers, including Minor White and Aaron Siskind, tried to convey a highly personal, almost spiritual view of the world.

The artistic possibilities of colour photography were not fully explored until the 1970's. Colour film had been popular among amateur photographers since it was first commercially produced in 1935. However, most professional photographers continued to work almost entirely with black-and-white film. The American photographers Ernst Haas and Marie Cosindas were among the first professionals to concentrate on colour photography. Haas's work includes both realistic landscapes and abstract compositions. Cosindas, who chiefly uses instant colour film, specializes in still lifes and portraits.

**Photography today** is firmly established as both an art form and an essential tool in communication and research. Nearly all major art museums hold exhibitions of photographs, and a number of museums specialize in photographic art. A picture by a well-known photographer, such as Paul Strand, may cost as much as a fine painting. At the same time, the practical value of photography has steadily risen in many fields, ranging from advertising to zoology.

Professional photography today includes a greater variety of styles and themes than ever before. But much of the work can be broadly classified as either *realistic* or

**Realistic images** form abstract patterns in the work of many art photographers today. In this picture by Harry Callahan of the United States, a group of trees is transformed into a striking composition by a skilful balance of line, space, and tone.

*fanciful.* Among the outstanding realistic photographers are Donald McCullin of Great Britain and Lee Friedlander of the United States. Many of their photographs vividly document the "social landscape" of their countries. Another realistic photographer is Harry Callahan of the United States, whose work includes detailed, sharply focused pictures that follow the principles of straight photography.

Fanciful photographers may distort the appearance of objects in their pictures to create an illusion or convey a mood. The American photographer Jerry Uelsmann produces dreamlike images by combining several negatives into a single print. Another American photographer, Eileen Cowin poses herself and her family in settings that suggest images from television soap operas.

Amateur photographers use a wide variety of equipment and techniques. Cameras range from simple fixed-focus models to adjustable ones that have interchangeable lenses and many built-in features. Home processing of both black-and-white and colour film has been simplified by easy-to-use equipment and fast-acting chemicals. Amateurs also shoot colour home movies with available light, and they make videotape films that can be shown on a television set.

One of the greatest technical advances in both amateur and professional photography has been the instant processing of film. Ever since the instant camera was introduced in 1947, manufacturers have steadily improved the efficiency and ease of instant processing. The original model was bulky and expensive. But some of today's instant cameras are about the size of a paperback book and cost no more than a good standard camera. Many studio cameras can be adapted for instant photography by means of special attachments.

**Related articles** in *World Book* include:

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Adams, Ansel
Brady, Mathew B.
Cameron, Julia M.
Cartier-Bresson, Henri
Daguerre, Louis J. M.
Eastman, George
Eisenstaedt, Alfred
Evans, Walker
Fairchild, Sherman M.
Herschel (Sir John F. W.)
Karsh, Yousuf
Land, Edwin H.
Lange, Dorothea
Lumière brothers
Niépce, Joseph N.
Riis, Jacob A.
Steichen, Edward
Stieglitz, Alfred
Strand, Paul
Weston, Edward

**Photographic equipment**

Airbrush
Camera
Flashbulb
Lens
Light meter
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**Types of photography**

Daguerreotype
Film industry
Holography
Kirlian photography
Photocopying
Photoengraving and photolithography
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**Other related articles**

Astronomy
Ballistics (picture)
Blueprint
Camera obscura
Colour
Filmstrip
Infrared rays
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Microfilm
Modelling
Polarized light
Space travel (pictures)

**Outline**

I. **The photographic process**
   A. Capturing light rays
   B. Focusing the image
   C. Exposing the film
   D. Developing the film
   E. Making a print

**II. Taking photographs**
- A. Composition
- B. Light
- C. Focusing
- D. Exposure

**III. Photographic equipment**
- A. Cameras
- B. Film
- C. Lighting equipment
- D. Filters

**IV. Developing and printing**
- A. Developing black-and-white film
- B. Printing black-and-white photographs
- C. Developing colour film
- D. Printing colour photographs
- E. Instant processing

**V. Making home movies**
- A. Planning
- B. Filming
- C. Recording sound
- D. Editing
- E. Showing films

**VI. History**

**Questions**

What is *depth of field*? How can it be controlled?
How does contact printing differ from enlarging?
Why do photographers use filters on cameras?
What is *time-lapse photography*?
What contribution did William H. Fox Talbot make to photography?
Which two controls on a camera regulate exposure?
Why is a fixer used in developing and printing?
How can you photograph a fast-moving subject?
What are some of the specialized lenses that can be used on certain types of cameras?
What causes graininess in a photograph?

**Photolithography.** See **Photoengraving and photolithography.**

**Photometer.** See **Light meter; Star** (Measuring brightness).

**Photomicrography** is the technique of taking magnified photographs of small objects, usually through a microscope. Photomicrography is used to investigate the nature of substances in many branches of science, including biology, forensic science, geology, medicine, and metallurgy.

Originally, images seen through the microscope had to be drawn by hand if a permanent record was required. Soon after the development of photography, ways were found of fitting a camera to a microscope. Records of microscopic images could then be made more quickly and with greater accuracy.

Photographs with magnifications of up to about 10 or 15 times can be obtained without a microscope, using an ordinary camera with its lens extended much farther than normal. The greater the extension, the greater is the magnification obtained. Photography at these low powers of magnification is often called *macrophotography.*

To reposition the lens, one or more spacers called *extension tubes* may be fitted between the lens and the camera body. Alternatively, an adjustable device called a *bellows unit* may be used. This gives greater versatility, as the spacing between the lens and camera body can be set to the precise distance required. The image is usually focused on the film by adjusting the distance between the camera and the object being photographed.

With a magnified image, any slight movement of the camera causes a relatively large movement of the image on the film. This results in blurring of the image if the movement occurs when the picture is taken. For this reason, the camera is usually fixed firmly in position. However, low-power macrophotography can be carried out with a hand-held camera if the object is illuminated by an electronic flashgun. Relatively little movement of the image can occur during the extremely short duration of the flash.

Although the *negative* or *transparency* obtained can be enlarged to produce an even bigger image, the amount of detail revealed cannot be increased indefinitely. This is because no lens can give an image that is absolutely sharp, so the very finest details in the object cannot be recorded. Lenses able to reveal the most detail are said to have a high *resolving power.* To increase the detail obtained in the image, a lens specially designed for such close work can be used instead of the normal camera lens.

For the highest magnification, a camera body is attached to the top of a microscope. In some cases, the camera lens is left in place as it contains an adjustable aperture, called an *iris diaphragm.* This is used to control the amount of light entering the camera. Also, the diaphragm setting determines the *depth of field* obtained—that is, the range of distances over which the object will be in focus.

In most equipment used for professional photomicrography, no camera lens is used. The camera body serves simply as a holder for the film. All the necessary controls, and systems for illuminating and viewing the object, are built into the microscope. The object is illuminated from the front if it is opaque. Transparent objects are usually illuminated from behind. Important details can be highlighted by using coloured lighting and a filter.

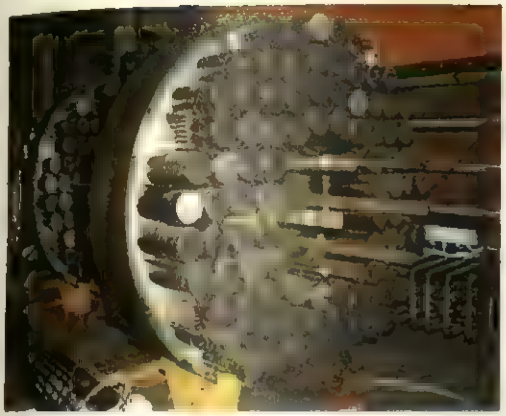
The best equipment produces photographs with useful magnifications of up to about 700 times, the highest magnification with an optical microscope. Further enlargement will not reveal any more detail.

See also **Microscope; Photography.**

**Photomultiplier tube** is an extremely sensitive electric detector of light. Most photomultipliers are more sensitive to light than is the human eye, and are used to measure very weak intensities of light. For example, physicists use them in scintillation counters to measure the light given off by cosmic rays, nuclear particles, gamma rays, or X rays (see **Radiation** [Scintillation counters]). Photomultiplier tubes are also used in some television cameras to enable clear pictures to be obtained at night.

A photomultiplier consists of an electronic vacuum tube containing several electrodes. Near the side exposed to light is a *photocathode,* which gives off electrons when light strikes it. These electrons then strike the first of a series of positively charged plates called *dynodes.* As the electrons bounce from plate to plate, they knock an ever-increasing number of electrons from each plate. The electrons eventually leave the tube via an electrode called the *anode,* or *collector.* Several million electrons may leave the tube for every electron given off by the photocathode. The tube thus multiplies the effect of the light that strikes it and enables the brightness of the light to be measured with extreme accuracy.

The *amplification* (strengthening) of the electron stream in the photomultiplier tube may be more than 1,000,000 times. However, there is a limit to the amount of useful amplification that can be produced in this way.



**Photomultiplier tubes** detect and amplify low-level light signals. The tubes shown here detect light flashes produced by subatomic particles in a particle physics laboratory.

Even in the dark, the photocathode gives off a few electrons. These are amplified, producing unwanted "noise" in addition to the signal resulting from light striking the photocathode. If there is little light to produce a signal, the noise may be stronger than the signal. No additional amount of amplification will enable the signal to be separated from the noise. The noise level will always be above that of the wanted signal, and will thus make it impossible to measure the signal.

**Photon** is the elementary particle that makes up light and all other forms of electromagnetic radiation. Although light, radio waves, X rays, and other forms of electromagnetic energy are usually thought of as waves in describing such effects as interference, diffraction, and polarization, there are certain effects that scientists cannot explain by means of the wave theory. For example, if you connect two charged metallic conductors, or electrodes, in a vacuum and shine a light on the negative electrode, a current will flow. This is known as the photoelectric effect (see **Photoelectric effect**). The current is produced by a stream of electrons knocked out of the atoms of the metal of the electrode by the particles we call *photons.*

The idea that light and other energy comes in the form of particles was developed in 1900. In that year, Max Planck, a German physicist, described light and other radiant energy in terms of streams of particles called *quanta.* Each *quantum* of energy is a "packet" that cannot be divided; you cannot have half a quantum of energy. But the amount of energy in a quantum can vary. A photon is a quantum of electromagnetic energy. In the photoelectric effect, the higher the energy a photon has, the higher will be the energy it gives to an electron when it knocks it out of an atom.

In 1902, Philip von Lennard, a German physicist, observed that the amount of energy given to an electron depended only on the colour of the light shone on the electrode. In 1905, the German-born scientist Albert Einstein worked out that the energy of a photon depends on its wavelength or frequency. A photon of violet light has a higher energy than a photon of red light because violet light has a higher frequency (or shorter wavelength) than red light.

The Compton Effect, discovered by the U.S. physicist Arthur Compton in 1922, gives the best proof that photons are indeed particles. When X-ray photons collide with electrons, both particles are deflected from their initial paths. The X-ray photon gives up some of its energy to the electron. As a result, the X-ray photon "falls" to a lower frequency (or a longer wavelength).

See also **Light; Quantum mechanics.**

**Photoperiodism** is the response of a plant or animal to the relative length of light and darkness to which it is exposed. Variations in light and dark affect such activities as the migration of birds and the falling of leaves.

Plants are of three photoperiodic types. *Short-day plants* flower only if exposed to light for less than a certain length of time each day. *Long-day plants* need a daily light period longer than a certain minimum time. *Day-neutral plants* bloom in either short or long photoperiods. In short- and long-day plants, the length of the dark period seems most important. Light influences on *phytochrome,* a bluish pigment, apparently cause photoperiodic behaviour in plants.

**Photosphere.** See **Sun** (Regions; illustration).

**Photosynthesis** is a food-making process that occurs in green plants. It is the chief function of leaves. The word *photosynthesis* means *putting together with light.* Green plants use energy from light to combine carbon dioxide and water to make sugar and other chemical compounds. All our food comes from this important energy-converting activity of green plants. Light energy is converted to chemical energy and is stored in the food made by green plants. Animals eat the plants, and we eat animal products as well as plants.

The light used in photosynthesis is absorbed by a green pigment called *chlorophyll.* Each food-making cell in a plant leaf contains chlorophyll in small bodies called *chloroplasts.* In chloroplasts, light energy causes water drawn from the soil to split into hydrogen and oxygen. In a series of complicated steps, the hydrogen combines with carbon dioxide from the air, forming a simple sugar. Oxygen from the water molecules is given off in the process. From sugar—together with nitrogen, sulphur, and phosphorus from the soil—green plants can make starch, fat, protein, vitamins, and other complex compounds essential for life. Photosynthesis provides the chemical energy that is needed to produce these compounds.

Certain bacteria and algae can also capture light energy and use it to make food. For example, *photosynthetic bacteria* contain chlorophyll in tiny bodies called *chromatophores.* In chromatophores, compounds other than water are combined with carbon dioxide to form sugar. No oxygen is released.

Green plants convert carbon dioxide and water into food and oxygen. Plants and animals, in turn, "burn" the food by combining it with oxygen to release energy for growth and other life activities. This process, called *respiration,* is the reverse of photosynthesis. Oxygen is used up and carbon dioxide and water are given off. Plants then use the carbon dioxide and water to produce more food and oxygen. The cycle of photosynthesis and respiration maintains the earth's natural balance of carbon dioxide and oxygen.

See also **Leaf** (How a leaf makes food; illustration); **Chlorophyll; Respiration.**

**Phototropism.** See **Plant** (Factors affecting plant growth).

**Phototypesetting.** See **Photocomposition.**

**Phrenology** is the practice of analysing a person's character by examining the shape of the skull. Phrenology was developed during the early 1800's by two German doctors, Franz Joseph Gall and Johann Kaspar Spurzheim. Phrenology was once considered a science. Most people now regard it as a *pseudoscience* (false science).

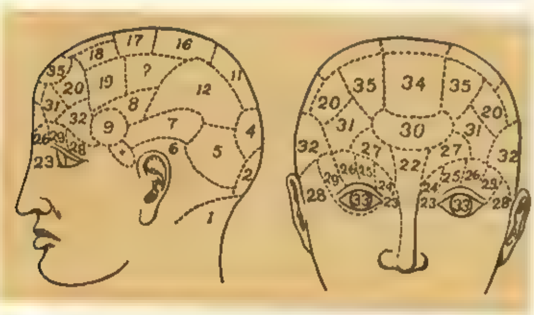
Phrenology was based on the belief that different areas of the brain control different aspects of behaviour. Gall and Spurzheim believed the skull could be mapped to show the locations of these areas, which they called *organs.* Some organs governed personality traits, and others controlled mental abilities.

According to phrenologists, a person's outstanding traits could be identified by bumps or bulges on the head. These swellings were caused by the enlargement of the organs related to each powerful trait. For example, a musician would have a well-developed *organ of tune* and a mathematician would possess a large *organ of number.* Phrenologists also believed that certain bumps identified people as poets or thieves.

Phrenology gained great popularity in Western Europe and North America during the early and mid-1800's. Notable people who believed in phrenology included Queen Victoria of Great Britain and the American poets Walt Whitman and Edgar Allan Poe.

Today, scientists know that a personality trait is not localized in any one area of the brain. Different parts of the brain have different functions, but the parts interact in a more complex way than phrenologists realized. Nevertheless, phrenology did help pave the way for the scientific study of personality, and thus for modern psychology.

**A phrenological chart** shows the supposed relation of personal abilities, talents, and emotions to the shape of the head.



**Affective**

**(I) Propensities**
- 1 Amativeness
- 2 Philoprogenitiveness
- * 3 Inhabitiveness or concentrativeness
- 4 Adhesiveness
- 5 Combativeness
- 6 Destructiveness and alimentiveness
- 7 Secretiveness
- 8 Acquisitiveness
- 9 Constructiveness

**(II) Sentiments**
- * 10 Self-esteem
- 11 Love of approbation
- 12 Cautiousness
- * 13 Benevolence
- * 14 Veneration
- * 15 Firmness
- 16 Conscientiousness
- 17 Hope
- 18 Wonder
- 19 Ideality
- 20 Wit
- * 21 Imitation

**Intellectual**

**(I) Perceptive**
- 22 Individuality
- 23 Form
- 24 Size
- 25 Weight
- 26 Colouring
- 27 Locality
- 28 Number
- 29 Order
- 30 Eventuality
- 31 Time
- 32 Tune
- 33 Language

**(II) Reflective**
- 34 Comparison
- 35 Causality

*Does not appear on these charts

**Phrygia** was an ancient country between the Mediterranean and Black Sea, in what is now central Turkey. The Phrygians were an Indo-European people who came from southeastern Europe after 1200 B.C. and settled in lands once ruled by the Hittites. Legends tell that the early Phrygian kings included Gordius and Midas, whose great rock tombs may still be seen in the mountains. See **Gordian knot; Midas.**

Cimmerians—invaders from around the Caucasus Mountains—conquered Phrygia in about 700 B.C. Phrygian communities still existed until about 550 B.C. The Phrygians later came under Persian, Greek, and then Roman rule. The Phrygians were known for their art and ceramics, and skill in tomb-building. They contributed many Oriental ideas to the early Greeks, especially in music. The Romans adopted the Phrygian worship of the goddess Cybele, the Great Mother of the Gods.

**Phuket** is the largest island in Thailand. It lies 885 kilometres south of Bangkok in the Andaman Sea. Phuket is connected to the mainland by the Sarasin Bridge. For the location of Phuket, see **Thailand** (map). Phuket is administered as a province of Thailand.

The island is popularly known as the *Pearl of the South.* Phuket was formerly called *Talang.*

The port of Phuket serves as one of the country's major outlets to the Indian Ocean. The local occupations include farming, tin mining, and fishing.

Tourism is also an important industry, making Phuket's inhabitants the richest people in Thailand. Phuket is a popular resort with its own international airport. The island offers visitors a varied and striking landscape with luxuriant forests, impressive cliffs, and vast sweeping beaches of both rock and sand. Many scuba divers are attracted to the surrounding waters.

The town of Phuket is geared toward the tourist industry with souvenir shops, craft markets, restaurants, and cinemas. Major attractions on the island include a marine biological centre; the spectacular limestone caves, grottos, and columns of Phang Nga Bay; Phra Taew National Park; and the Temple of the Golden Buddha. An important colourful event in Phuket is the Chinese Vegetarian Festival which takes place in autumn. The festival marks the end of a fast from eating meat, and includes displays of fire-walking and climbing knife-edged ladders.

**Phyfe, Duncan** (1768-1854), was a well-known American cabinetmaker and furniture designer. Phyfe popularized the Federal style of American furniture. He adopted this style from the English neoclassical style of the mid-1700's.

Phyfe based his designs on English pattern books of his day, especially those of Thomas Sheraton and Thomas Hope. Phyfe became known for his chairs, benches, and other seating furniture. He manufactured chairs with backs shaped like scrolls. The chairs had a

*splat*—a piece of wood that formed the centre of the back. A typical splat was shaped like a harp or a lyre.

Phyfe was born in Loch Fannich near Inverness, Scotland. He emigrated to America in 1782. By 1792, Phyfe had established a shop in New York City. He eventually operated one of the largest furniture factories in the United States.

See also **Furniture** (Early American furniture).

**Phylloxera** is any one of a group of small plant lice. They feed on trees and shrubs.

One of the most important kinds of phylloxerae is the *grape phylloxera.* This insect sucks the sap from the leaves and roots of grapevines, causing *galls* (swellings). The damage to the root stunts and often kills the vine. The grape phylloxera is native to the eastern United States. The vines in this region resist them, but these insects do much damage in the western United States and in Europe. They are controlled by grafting the vines to rootstock from the eastern United States and by periodically flooding or fumigating the soil.

**Tiny phylloxerae,** a form of plant lice, attack the leaves and roots of grapevines.

The life cycle of the grape phylloxera lasts two years. Fertilized eggs are laid under the bark of the vine in the autumn. In the spring, these eggs hatch into wingless young that move to the leaves to feed. They lay unfertilized eggs which soon hatch. Several of these generations are produced during the summer. In the autumn, the young insects move to the roots and hibernate there during the winter. During the next spring and summer they feed on the roots and produce young from unfertilized eggs. As autumn approaches, winged insects are produced that lay eggs in other vines. After these eggs hatch, the insects mate, the females lay fertilized eggs, and the cycle repeats.

**Scientific classification.** Phylloxerae are in the aphid family, Aphidae. The grape phylloxera is *Daktulosphaira vitifoliae.*

**Phylum.** See **Classification, Scientific.**

**Physiatrics.** See **Physical therapy.**

**Physical change** is a change of matter from one form to another without any change in its chemical structure, solubility, colour, taste, or odour. When a piece of wood is made into sawdust, the change is a *physical change.* If the piece of wood were burned, the wood would turn into new substances, ash and gases, and the change would be chemical. Another example of a physical change is the melting of ice to water. Physical changes sometimes require energy, as when water is changed to steam by heat.

**Physical chemistry** is the study of the general rules and principles that govern the chemical properties of matter. It is primarily concerned with (1) whether a particular chemical reaction will occur and (2) how fast and by what mechanism the reaction will proceed. Students of physical chemistry study such problems as how and why atoms join together in molecules; how atoms and molecules form gases, liquids, and solids; how atoms and molecules absorb and emit energy; and how electricity is related to chemistry.

**Physical disability.** See **Handicapped.**

**Physical education** is the part of the school curriculum that instructs students in body movements, sports and games, and other physical activities. In many countries, physical education is taught in both primary and secondary schools. It is also a subject on many college syllabuses. In many countries, degree courses or teaching diplomas exist in physical education. It is also an extremely important element in military training.

Physical education involves a wide variety of activities, including elementary games, basic skills in movement (such as running or jumping), and exercises to improve and promote physical fitness, muscle tone, and body condition. Team sports, recreational activities such as swimming, and creative movements such as dance and gymnastic exercises, all form important aspects of physical education as a discipline.

Physical education courses help build up physical fitness by allowing students to increase their endurance, strength, and flexibility. Students learn about the effects of different movement activities on their bodies. They also learn exactly what level of strenuous physical activity their bodies can withstand.

In primary school, physical education courses centre on helping children develop and understand basic body movements. They also include elementary games that

**Physical education** involves a variety of activities, including individual and team sports. Secondary school students, *above,* run an obstacle course.

emphasize participation and cooperation rather than competition. Dance activities and exercises done to music are also included. In the more advanced primary school classes, simple competition sports, games, and exercises may be taught. Physical education teachers also lay the foundation of exercising for physical fitness and health. Secondary school physical education programmes continue and extend these activities and provide the basis of lifelong recreational and sporting pursuits such as archery, athletics, badminton, cricket, cycling, golf, rugby football, soccer, swimming, and tennis. Many further education colleges and universities provide opportunities for continuing physical education.

**History.** Many experts trace the beginnings of physical education back to the ancient Greeks, who had organized physical education programmes by the 700's B.C. At educational establishments called *gymnasia* (gymnasiums), Greek boys took part in discus- and javelin-throwing, jumping, running, and wrestling. They also received instruction in mathematics, philosophy, and rhetoric. Although physical education was also an integral part of the general education of Roman citizens, its primary value was in military training.

In Europe in the Middle Ages (from the 400's to the 1500's), many sports and other physical activities were considered sinful. During the Renaissance, which lasted from the 1300's to the 1600's, a revival of interest in Greek and Roman culture brought a return to competition and fitness sports and bodybuilding activities.

In the 1800's, physical education programmes were introduced into schools in Germany, Sweden, the United Kingdom, and the United States. German and Swedish programmes emphasized gymnastics and exercise routines. The British programmes laid stress on team sports. U.S. programmes borrowed from all these European sources. The most important development in the 1900's was the large-scale provision of physical education courses for girls and for people with disabilities.

**Physical education** in primary schools helps children develop basic body movements, *top*. College students pursuing a physical education degree study anatomy, *bottom*.

**Physical fitness** is a combination of qualities that enable a person to perform well in vigorous physical activities. These qualities include agility, endurance, flexibility, and strength. Physical fitness and good health are not the same, though each influences the other. Healthy people may be physically unfit because they do not exercise regularly. Physically fit people perform their usual tasks easily without tiring.

Better physical performance is only one benefit of physical fitness. Regular vigorous exercise also increases the efficiency and capacity of the heart and lungs and helps people maintain their proper weight. Individuals who are physically fit tend to be slimmer than those who are unfit. They have greater resistance to disease and recover faster if they do become ill. Physically fit people may be happier and more alert and relaxed. They also may be able to resist the effects of aging better than those who are physically unfit.

### Principles of physical fitness

Physical fitness is a personal responsibility. Few individuals other than athletes and military personnel are actually required to participate in organized fitness programmes. Most people are physically unfit simply because they do not get enough exercise. Many do not take the time to exercise, and others try to stay fit with only light, infrequent activity.

A person's physical fitness is determined by such factors as age, heredity, and behaviour. Although people cannot control their age or heredity, their behaviour can help them become physically fit and stay that way. Individuals vary greatly in their capacity for physical fitness, but almost anyone can improve by exercising regularly.

The years between adolescence and middle age are the peak period for physical fitness. However, people of all ages can stay fit with good health habits and regular exercise. Any person more than 35 years old, and anyone with a health problem, should consult a doctor before beginning a fitness programme.

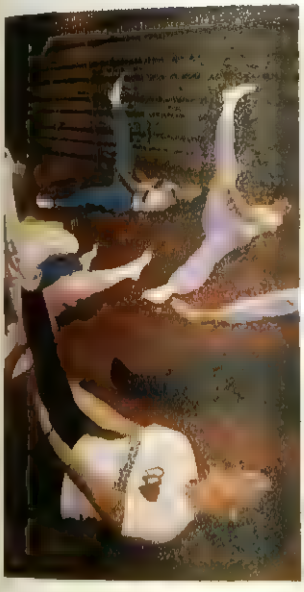
Health habits that aid physical fitness include getting enough sleep, eating properly, receiving regular medical and dental care, and maintaining personal cleanliness. Health can be harmed by overeating and eating the wrong kinds of foods; smoking; and drug abuse, including excessive use of alcohol. Harmful health habits can undo the results of regular exercise.

A person's level of physical fitness depends largely on how frequently and intensely he or she exercises. Most health experts agree that people should exercise at least three times a week to maintain desirable fitness. Improvement occurs faster with more frequent workouts.

Physical fitness experts recommend a 30-minute workout of continuous exercise. The exercise need not be difficult or strenuous. However, as a person's condition improves, he or she should increase the number of times each activity is performed. Every workout should

**Some ways to achieve physical fitness**

Women in a physical fitness class exercise to keep their muscles strong and limber, *left.* Runners jog in a park to build their strength and endurance, *centre.* Many people keep fit by maintaining an exercise programme that includes weightlifting on specialized machines, *right.*



include three basic types of exercises: (1) flexibility exercises, (2) endurance exercises, and (3) strength exercises.

Flexibility exercises, such as bending, turning, and twisting movements, stretch the connective tissues and move the joints through a wide range of motions. These exercises cut the risk of injury from strenuous exercise and reduce muscle soreness. They should be performed before and after each workout.

Endurance exercises include cycling, running, and swimming. These activities, also called *aerobic exercises,* raise the rate of heartbeat and breathing and strengthen the circulatory and respiratory systems.

Strength exercises include pullups, pushups, situps, and exercises with weights. They strengthen the arms and shoulders and other muscular parts of the body.

### Physical fitness programmes

**School programmes** help children develop good physical fitness habits. Fitness during childhood influences fitness as an adult. By the time most people reach adulthood, their fitness habits have been firmly established.

It has been recommended that all primary and secondary schools should provide a daily exercise period of at least 20 minutes. This period should include vigorous activities designed to develop agility, endurance, flexibility, and strength.

An effective school programme should offer regular health examinations, courses in health care, and performance tests to measure students' progress in physical fitness. Such a programme also provides instruction in running, throwing, and other skills, and special programmes for handicapped and retarded students.

Physical fitness programmes should teach the younger children simple exercises and progress to more complicated ones as the children mature. Older pupils can participate in such activities as gymnastics, swimming, and dual and team sports. Secondary school programmes should include *intramural sports,* which involve competition among students of the same school, and *interscholastic sports,* in which schools compete against one another.

**Community programmes** contribute to the physical fitness of the people by increasing the opportunities for exercise. A community needs leadership, adequate facilities, and good organization to develop successful fitness programmes. These programmes should meet the needs of residents with different interests and skills.

In many communities, schools become recreation and fitness centres during evenings and weekends and on days when the regular classes are not held. Schools can offer sports equipment and such facilities as gyms, playing fields, running tracks, and swimming pools. Some communities have special paths for cycling and jogging.

Many business companies, labour and service organizations, churches, private clubs, and park and recreation agencies provide facilities and instructors for community programmes. A number of firms have fitness programmes for their own employees.

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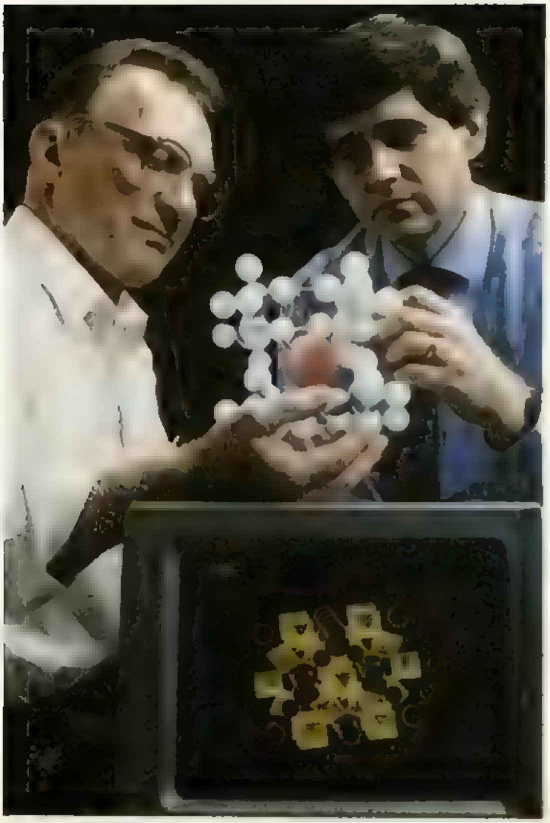
| Health | | |

**Physical geography.** See Geography (Divisions of geography).

**Physical science.** See Science (The physical sciences).

**Physical therapy.** See Physiotherapy.

**Physician.** See Medicine.



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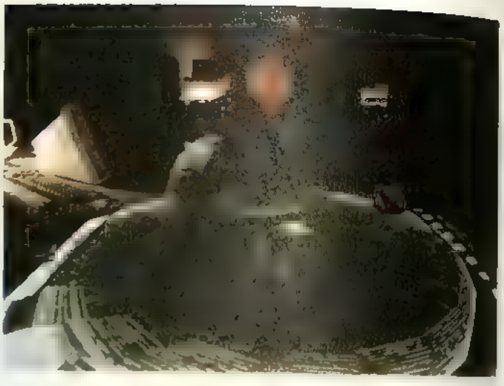


Scanning the tracks of subatomic particles

Developing protective coatings for metals

**Research in physics** explores the structure and behaviour of matter and attempts to answer questions about energy. The work of physicists includes developing theories, performing experiments, and improving manufacturing processes and products.

# Physics

**Physics** is the science devoted to the study of matter and energy. Physicists try to understand what matter is and why it behaves the way it does. They seek to learn how energy is produced, how it travels from place to place, and how it can be controlled. Physicists are also interested in how matter and energy are related to each other and how they affect each other over time and through space.

The word *physics* comes from a Greek word meaning *natural things*. Solid-state physicists developed the transistor and other semiconductor devices. These devices contributed to the enormous growth of the electronics industry since World War II. Knowledge obtained from the study of physics is important in other sciences, including astronomy, biology, chemistry, and geology. There is also a close connection between physics and practical developments in engineering, medicine, and technology. For example, engineers design cars and aeroplanes according to certain principles of physics. Laws and theories of physics have enabled engineers and scientists to put satellites into orbit and to receive information from space probes that travel to distant regions of the solar system. Research in physics has led to the use of radioactive materials in the study, diagnosis, and treatment of certain diseases. In addition, theories and principles of physics explain the operation of many modern home conveniences, from vacuum cleaners to videotape recorders.

## What physicists study

Physicists try to answer basic questions about the world, how it is put together, and how it changes. Some physicists, called *experimental physicists*, perform carefully designed experiments and then compare their results with what was predicted to happen. Such predictions come from laws and theories developed by another group of physicists, called *theoretical physicists*. These laws and theories are almost always expressed in the language of mathematics, a basic tool of physics.

The subjects studied by physicists consist of two broad categories, *classical physics* and *modern physics*. These two categories differ primarily in emphasis. Classical physics deals with questions regarding motion and

energy. It is composed of five basic areas: (1) mechanics, (2) heat, (3) sound, (4) electricity and magnetism, and (5) light. Modern physics concentrates on scientific investigations of the basic structure of the material world. Its major fields include (1) atomic, molecular, and electron physics; (2) nuclear physics; (3) particle physics; (4) solid-state physics; and (5) fluid and plasma physics.

**Mechanics** is the study of bodies at rest and in motion. For example, it describes how force acts upon an object to produce acceleration. The mechanics of bodies in motion is sometimes referred to as *dynamics*. The mechanics of bodies at rest is called *statics*. One branch of mechanics, known as *fluid mechanics*, deals with the behaviour of liquids and gases. Principles of mechanics are used in describing such types of motion as planetary orbits and the paths of other moving objects. They are also important to designers of bridges and other structures, containers, roads, and various kinds of vehicles. See **Mechanics; Dynamics; Statics.**

**Heat.** The study of heat is called *thermodynamics*. It involves investigating how heat is produced, how it is transmitted from one place to another, how it changes matter, and how it is stored. Heat energy can be transformed into other kinds of energy, and other kinds of energy can be transformed into heat energy. For example, when coal is burned, the chemical energy that binds its molecules is partially transformed into heat. Thermodynamics also includes *cryogenics*, the study of material at very low temperatures. Principles of thermodynamics are essential for understanding all types of heat engines, which include diesel, petrol, and steam engines, as well as refrigerators and freezers. See **Heat; Thermodynamics.**

**Sound.** The study of sound is called *acoustics*. Sound consists of vibrations that are produced by an object and which travel through a medium, such as air, water, or the walls of a building. Understanding sound is important for designing auditoriums, hearing aids, tape recorders, record players, and speakers. The study of sound also includes *ultrasonics*, which deals with vibrations that have frequencies too high for human beings to hear. See **Acoustics; Sound.**

**Electricity and magnetism** are so closely related that scientists often refer to the two of them together as *electromagnetism*. The motion of electric charges can produce magnetic effects, and magnetic forces can produce electrical effects. Knowledge of this relationship has led to the development of huge electric generators and such electronic devices as radios, televisions, and computers. See **Electricity; Electromagnetism; Electronics; Magnet and magnetism.**

**Light.** The study of light is called *optics*. Optics has two major branches, *physical optics* and *geometrical optics*. In physical optics, physicists study the nature of light and the physical processes by which it is *emitted* (given off) from bodies and transmitted from place to place. Geometrical optics is the study of how light travels from place to place, and how the direction of travel is affected by different materials. Such study is important in understanding the lenses and mirrors that are used in telescopes, microscopes, and spectacles. See **Light; Optics.**

**Atomic, molecular, and electron physics** are concerned with understanding the structures of molecules and atoms. In particular, they concentrate on the behaviour, arrangement, motion, and energy states of the electrons that orbit atomic nuclei. Studies in atomic, molecular, and electron physics have revealed much about the structure of matter. For example, scientists have determined that substances differ from one another in the arrangement of the atoms of their molecules. Because of this difference, the way that each substance absorbs and emits electromagnetic energy is unique. As a result, scientists are able to identify a substance on the basis of its electromagnetic activity alone. This method of identifying substances has important applications in medicine and in certain industrial situations where minute amounts of a material are involved. See **Atom; Electron; Molecule.**

**Nuclear physics** involves the study of the structure and properties of the atomic nucleus. It focuses on radioactivity, fission, and fusion. *Radioactivity* is the process by which certain nuclei spontaneously give off high-energy particles or rays. Radioactive materials are used to treat cancer and diagnose illnesses, and to trace chemical and physical processes. *Fission* is the process in which an atomic nucleus splits into two nearly equal parts, releasing a huge amount of energy. It provides the energy for atomic bombs and nuclear reactors. *Fusion* is the process in which the nuclei of two atoms join

**Major branches of physics**

**Acoustics** studies the production and properties of sound.
**Atomic physics** examines the structure, properties, and behaviour of the atom.
**Biophysics** applies the tools and techniques of physics to the study of living things and life processes.
**Cryogenics** is the study of extremely low temperatures.
**Electrodynamics** analyses the relationship between electrical and magnetic forces.
**Fluid physics** deals with the behaviour and movement of liquids and gases.
**Geophysics** is the study of the earth and its atmosphere and waters by means of the principles of physics.
**Health physics** involves the protection of people who work with or near radiation.
**Mathematical physics** is the study of mathematical systems that stand for physical phenomena.
**Mechanics** deals with the behaviour of objects and systems in response to various forces.
**Molecular physics** examines the structure, properties, and behaviour of molecules.
**Nuclear physics** is concerned with the structure and properties of the atomic nucleus, and with nuclear reactions and their applications.
**Optics** is the study of the nature and behaviour of light.
**Particle physics,** also called *high-energy physics*, analyses the behaviour and properties of elementary particles.
**Plasma physics** is concerned with the study of highly *ionized* gases—that is, gases that have been separated into positively and negatively charged particles.
**Quantum physics** includes various areas of study based on *quantum theory*, which deals with matter and electromagnetic radiation, and the interactions between them.
**Solid-state physics,** also called *condensed-matter physics*, examines the physical properties of solid materials.
**Thermodynamics** is the study of heat and other forms of energy, and of the conversion of energy from one form to another.

together to form the nucleus of a heavier element. It occurs primarily with hydrogen and other light elements. Fusion, which releases even more energy than does fission, produces the energy of the hydrogen bomb. See **Nuclear physics.**

**Particle physics.** Physicists have discovered that the protons and neutrons within atomic nuclei are formed of still more elementary particles. Particle physicists conduct research by using devices called *particle accelerators.* These devices can raise subatomic particles to very high speeds. When these particles have reached speeds very close to the speed of light, they are allowed to collide with ordinary matter. Physicists then study the fragments that result from the collisions and measure their energy. In this way, they hope to understand how elementary particles are joined together to make protons, neutrons, and other subatomic particles. See **Particle accelerator; Particle physics.**

**Solid-state physics,** also called *condensed-matter physics.* Solids may be classified according to how the electrons and nuclei of the different atoms that make them up interact with each other. Physicists who study solids are interested in how the properties of these materials are affected by such factors as temperature and pressure. For example, at extremely low temperatures, some solids lose all electrical resistance, thereby becoming *superconductors.* Research on the electronic structure of solids is especially important in understanding the behaviour of *semiconductors,* which serve as the basis of modern electronic devices. See **Semiconductor; Solid-state physics; Superconductivity.**

**Fluid and plasma physics.** The modern physics of fluids is built on the principles of classical fluid mechanics. Understanding the behaviour and movement of fluids is important for the design and construction of cars, ships, aeroplanes, and rockets, as well as for the study of weather. Plasma physics concerns the study of gases called *plasmas.* If enough energy is introduced into a gas, the gas becomes *ionized* (separated into positively and negatively charged particles). The resulting gas is a plasma. Plasmas are used in neon lights and fluorescent lamps. Physicists are studying how plasmas might be controlled and used to produce fusion energy to generate electricity. See **Hydraulics; Mechanics; Plasma.**

## History

Through the centuries, physics has been closely linked to developments in technology and to advances in mathematics, astronomy, and other sciences. The use of the word *physics* in its current sense was first recorded in the 1700's.

**The beginnings** of physics date back to prehistoric times. Stonehenge and the other huge rock structures prehistoric people built indicate that they had some knowledge of mechanics. Such knowledge would have been necessary for them to transport these rocks and to place them on top of one another. In addition, there is some evidence that prehistoric people may have used these rock structures to mark significant moments in the seasonal cycle of the sun and moon.

The first people to leave written records of their discoveries and inventions were the Sumerians, Babylonians, and Egyptians. By around 3000 B.C., the Sumerians had developed a number system, and they used algebraic formulas for following and predicting movements of the stars, sun, moon, and planets. Similar developments occurred in Egypt and Babylonia. The Egyptians also developed practical geometric techniques for use in construction and land surveying.

**The Greeks** appear to have been the first people to develop general theoretical systems of mathematics and natural science. Beginning about 600 B.C., they developed a general understanding of the principles of geometry. The Greek mathematician Euclid organized these principles into a unified system in about 300 B.C.

The Greeks were keen observers of the physical world. In the 300's B.C., the philosopher Aristotle provided proofs, based on physical evidence, of the spherical shape of the earth. In the 200's B.C., the astronomer Eratosthenes calculated the circumference of the earth, and Aristarchus, another astronomer, estimated the relative distances to the moon and sun. Also during the 200's B.C., the inventor and mathematician Archimedes discovered several basic scientific principles and developed a number of measuring techniques.

In the A.D. 100's, Ptolemy, an astronomer in Egypt, developed a model for predicting the positions of the sun, moon, stars, and planets. Like Aristotle and other Greek philosophers, Ptolemy viewed the earth as the centre of the universe. Ptolemy's system served as a guide for predicting the motion of the heavenly bodies for nearly 1,500 years.

**The Middle Ages** began in about the 400's with the fall of the Roman Empire. At that time, records of Greek scientific discoveries were lost to western Europe. From about 400 to 1000, western Europeans had little interest in scientific learning. Most educated people felt that religion, rather than scientific investigation, should provide the answers to questions about the universe.

Much of the Greek written tradition in science was preserved during the early Middle Ages by people in the Middle East. These people translated many of the Greek works into Arabic. Arabic scholars wrote commentaries on these texts, made astronomical observations to correct Ptolemy's system of the universe, and performed experiments in optics and mechanics.

Trade between the Arab cultures of the East and the Christian cultures of the West increased during the 1000's. As a result, Greek scientific documents were reintroduced into the West, this time as translations from Arabic to Latin. At first, the science of Aristotle and other Greeks was rejected by the church. But during the 1200's, Saint Albertus Magnus, Saint Thomas Aquinas, and other religious scholars successfully reconciled Aristotelian physical science with church principles.

During the 1100's and 1200's, there was also increasing interest in scientific observation and experiments. For example, various writings, including those of the English scholars Robert Grosseteste and Roger Bacon, proposed effective methods for scientific research.

Practical inventions in agriculture and other fields also sparked scientific inquiry in Europe during the Middle Ages. In China and other Asian countries, scientific activity and invention flourished during this period. However, unlike in the West, science and technology had little influence on each other.

**The Renaissance** is the name given to the period in Europe that extended from about the early 1300's to

about 1600. It was a time of social, economic, political, and intellectual excitement that produced many new approaches in both the arts and the sciences.

In the 1300's, at Oxford University and the University of Paris, such scholars as Richard Swineshead and Nicole Oresme investigated the problem of the description of motion. During the 1400's and 1500's, the famous Italian painter and inventor Leonardo da Vinci also conducted studies of motion and hydraulics.

In 1543, the Polish astronomer Nicolaus Copernicus published a revolutionary system of the universe in which he placed the sun—instead of the earth—at the centre. Copernicus proposed that the earth was one of the planets, all of which orbited the sun. At the time, almost no one accepted his point of view. Catholic and Protestant leaders alike felt that his system was in conflict with their religious beliefs. There were also serious scientific objections to the system. Acceptance of the Copernican system required a complete rethinking of the whole basis of physical science. Such a rethinking did in fact occur over the next 150 years, primarily through the work of such major figures as Galileo, Johannes Kepler, and René Descartes.

Beginning in 1609, the Italian astronomer and physicist Galileo built a number of telescopes for observing the heavens. While none of Galileo's observations with his telescopes proved the Copernican system, they did call traditional views into question. Galileo also perfected the idea of the laboratory experiment in his study of the motion of falling bodies. He showed that a person could gain an understanding of the way objects fall toward the earth by assuming that, in the absence of disturbing influences, all objects accelerate at the same constant rate.

In the early 1600's, the German astronomer and mathematician Johannes Kepler used the observations of others to construct a new and accurate model of the solar system. In the mid-1600's, René Descartes, a French philosopher and mathematician, challenged the long-standing assumption that an absence of motion was the natural state of all objects. Instead, he proposed that objects have *inertia*—that is, they maintain whatever their state of motion unless otherwise disturbed.

The work of Galileo, Kepler, and Descartes reflects a change in attitude that occurred during the Renaissance. People had begun to believe that the physical world was governed by natural laws, and that it was possible to discover those laws. The path to such discovery was now seen to begin with careful measurements carried out, if possible, under controlled laboratory conditions.

**Newton.** By the 1600's, a great deal of scientific activity was underway. The climax of this increased activity was the publication, in 1687, of *Mathematical Principles of Natural Philosophy,* by the brilliant English scientist, Sir Isaac Newton. In this work, Newton showed how both the motions of heavenly bodies and the motions of objects on or near the surface of the earth could be explained by four simple laws. These laws were Newton's three laws of motion and his law of universal gravitation.

Newton's laws of motion summarized and extended the work of Galileo and Descartes. His law of universal gravitation explained both Galileo's law of falling bodies and Kepler's laws of planetary motion. In order to conduct some of his research and calculations, Newton invented a new form of mathematics, called *calculus.* Another mathematical scholar, Gottfried Wilhelm Leibniz of Germany, independently developed calculus at about the same time. See **Calculus.**

In addition to his theoretical discoveries, Newton constructed the first reflecting telescope. Using prisms, he performed ingenious experiments on light that led him to propose that white light was a mixture of all colours. In 1704, he published a particle theory of light. This theory competed with another theory of light that had been proposed by the Dutch physicist Christiaan Huygens in 1678, but not published until 1690. Huygens had

**Important dates in physics**

**300's B.C.** Aristotle formed theories in many areas of physics.
**200's B.C.** Archimedes discovered the law of the lever and laws for the behaviour of liquids.
**A.D. 100's** Ptolemy pictured the earth as standing still, with the sun, moon, planets, and stars moving in circles around it.
**c. 1270** Roger Bacon conducted studies in optics.
**1543** Nicolaus Copernicus wrote that the earth and planets move in circles around the sun.
**c. 1600** Galileo discovered important laws in many fields of physics, especially mechanics.
**1687** Sir Isaac Newton published his laws of motion.
**1690** Christiaan Huygens published a wave theory of light.
**1798** Benjamin Thompson, Count Rumford, stated that the motion of particles in a substance produces heat.
**1801-1803** Thomas Young revived the wave theory of light.
**1803** John Dalton first proposed his atomic theory about the structure of matter.
**Early 1830's** Michael Faraday and Joseph Henry independently produced electricity using magnetism.
**1847** James P. Joule found that heat and energy are interchangeable at a fixed rate.
**1864** James Clerk Maxwell published his electromagnetic theory of light.
**1887** The Michelson-Morley experiment disproved the existence of the ether.
**1895** Wilhelm K. Roentgen discovered X rays.
**1896** Antoine Henri Becquerel discovered natural radioactivity.
**1898** Marie Curie and her husband, Pierre, isolated the radioactive element radium.
**1900** Max Planck published his quantum theory.
**1905** Albert Einstein published his special theory of relativity.
**1911-1913** Ernest Rutherford and Niels Bohr proposed "planetary system" models of the atom.
**1915** Einstein announced his general theory of relativity.
**1924** Louis de Broglie put forth the wave theory of the electron.
**1925-1926** Erwin Schrödinger and Werner Heisenberg independently developed systems for organizing quantum physics.
**1930** Paul A. M. Dirac predicted the existence of the *positron,* a positively charged electron.
**1932** Sir John D. Cockcroft and Ernest T. S. Walton built the first particle accelerator.
**1938** Otto Hahn and Fritz Strassman achieved fission of the uranium atom.
**1942** Enrico Fermi and associates achieved the first controlled nuclear chain reaction.
**1947** John Bardeen, Walter H. Brattain, and William Shockley invented the transistor.
**1960** Theodore H. Maiman built the first laser.
**1964** Murray Gell-Mann and George Zweig proposed the existence of quarks as fundamental particles.
**1974** Burton Richter and Samuel C. C. Ting discovered a type of subatomic particle called the *psi particle* or *J particle.*
**1983** Researchers led by Carlo Rubbia discovered three subatomic particles—the $W^+$ and $W^-$ *particles* and the $Z^0$ *particle.*

argued that light travelled in the form of waves, rather than particles. But during the 1700's, most scientists accepted Newton's particle theory.

**Developments in the 1800's.** The Industrial Revolution, which had begun in Great Britain in the 1700's, led to the production of scientific instruments that were extremely accurate for their time and which enabled scientists to perform more complicated experiments. As scientific research grew more complex, people began specializing in more narrowly defined areas of study. Three areas of particular interest in the 1800's were heat and energy, light, and electricity and magnetism.

***Developments in the study of heat and energy.*** At the beginning of the 1800's, it was widely believed that heat existed in the form of a fluid, called *caloric.* But by the middle of the century, scientists had come to view heat not as a fluid, but as a form of energy. That is, they had learned that heat is able to do work. In the 1840's, James Joule, an English physicist, showed how to calculate how much work a given quantity of heat could do. About the same time, a number of physicists, including Lord Kelvin of Great Britain and Hermann von Helmholtz of Germany, independently proposed the law of conservation of energy. This law states that energy cannot be created or destroyed, only transformed from one kind to another. See **Energy** (The conservation of energy).

By the mid-1800's, heat energy also came to be interpreted as the mechanical movement of the atoms of which everything was made. This interpretation was based on the atomic theory proposed in 1803 by John Dalton, an English chemist.

***Developments in the study of light.*** From 1800 to 1803, the English physicist Thomas Young published a series of papers, based on experiments he had done, that revived the theory that light existed in the form of waves. From about 1815 to 1819, Augustin Fresnel, a French physicist, provided still more evidence. By 1850, the wave theory of light was almost universally accepted, replacing Newton's particle theory.

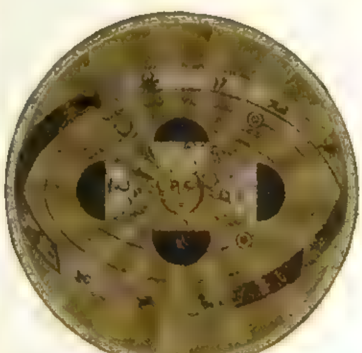
The wave theory of light led physicists to propose the existence of a material called the *ether.* They reasoned that if light travelled in waves and could travel through a vacuum, there had to be some medium present to support the waves. They concluded that all space, including vacuums, was filled with the ether. They interpreted light energy as simply the vibration of the ether, in the form of waves. See Ether.

***Developments in the study of electricity and magnetism.*** In 1800, Count Alessandro Volta of Italy announced his invention of the first electric battery. This invention opened the way for new methods of studying electrical effects. About 1820, two physicists, André Marie Ampère of France and Hans Christian Oersted of Denmark, showed that electricity and magnetism were related. In the early 1830's, the English physicist Michael Faraday and the American physicist Joseph Henry independently demonstrated how to produce electricity in a changing magnetic field. Their demonstrations showed that mechanical energy could be converted into electrical energy and suggested the principles behind the generator and the motor.

In the 1860's, the Scottish physicist and mathematician James Clerk Maxwell developed a theory that interpreted visible light as the movement of electromagnetic waves. Maxwell predicted the possible existence of similar electromagnetic waves that were invisible. Heinrich Hertz, a German physicist, detected such invisible *radio waves* in the late 1880's. Hertz's discovery eventually led to the development of radio, radar, and television. But it also suggested that light, electricity, and magnetism were related. All three were viewed as resulting from waves in the ether. Such waves are sometimes referred to as *electromagnetic radiation.*

**The beginning of modern physics.** Near the end of the 1800's, many physicists were convinced that the work of physics was nearly over. They believed that almost all the laws governing the physical universe had been discovered. Some of them believed that all physi-

**Archimedes,** a Greek inventor, discovered several basic principles of physics during the 200's B.C. He also developed a number of measuring techniques.



**The system of the universe** proposed by Polish astronomer Nicolaus Copernicus in 1543 placed the sun, not the earth, at the centre.

**Galileo** in Italy discovered the law of falling bodies and the law of the pendulum. In 1609, he began building telescopes to observe the heavens.

cal laws would one day be expressed in a few simple equations.

A few problems remained to be solved, however. One such problem involved determining the source of electromagnetic radiation. Scientists knew that under the right conditions, each chemical element radiates a unique combination of visible, infrared, and ultraviolet light, called *line spectra*. At the time, the atom was considered to be the most fundamental unit of matter in the universe. But to some physicists, the line spectra phenomenon suggested that the atom might itself be composed of still more fundamental units.

The dream of explaining all physical phenomena with one small set of basic laws was not realized. Instead, various discoveries began to reveal that such phenomena were more complex than scientists had thought. In 1895, for example, Wilhelm Roentgen of Germany discovered X rays. In 1896, the French physicist Antoine Henri Becquerel discovered *natural radioactivity*, the spontaneous emission of radiation from atoms. In 1897, the English physicist Joseph J. Thomson discovered the first subatomic particle, later called the *electron*. In 1898, French physicists Marie Curie and her husband, Pierre, isolated the radioactive element radium. Such developments signalled that, rather than being nearly over, the work of physics had only begun.

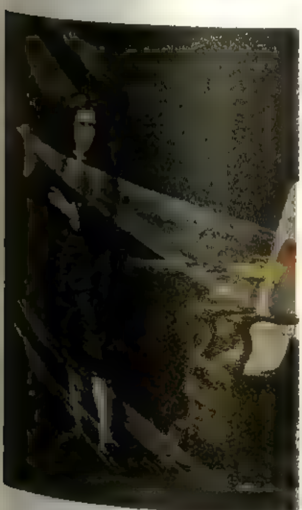
**Quantum theory.** The early 1900's brought revolutionary developments in physics. Scientists looked for inconsistencies in the classical physics of Newton and others, and discovered new interpretations of observed events.

In 1900, the German physicist Max Planck published his quantum theory of energy transfer to explain the spectrum of light emitted by certain heated objects. He stated that energy is not given off continuously, but in the form of individual units called *quanta*. In 1905, Albert Einstein, the German-born American physicist, proposed a new particle, later called the *photon*, as the carrier of electromagnetic energy. Einstein said that light, in spite of its wave nature, must be composed of these energy particles.

In 1913, the Danish physicist Niels Bohr explained in terms of quanta how atoms absorb and radiate energy. In 1924, Louis de Broglie, a French physicist, proposed that electrons could also exhibit wave properties. In the mid-1920's, two physicists, Erwin Schrödinger of Austria and Werner Heisenberg of Germany, produced separate, but equivalent, systems for organizing all earlier quantum physics. The combined ideas of Schrödinger and Heisenberg have since been developed as the field of *quantum mechanics*. See **Quantum mechanics**.

**Einstein and relativity.** During the 1800's, physicists tried unsuccessfully to measure the speed of the earth relative to the ether. According to classical physics, the ether was motionless. In the early 1880's, Hendrik A. Lorentz, a Dutch physicist, explained the failure of these experiments by assuming that the ether was partially dragged along as the earth moved through it. Two American physicists, Albert A. Michelson and Edward W. Morley, developed an instrument that made far more precise measurements than earlier devices. Their experiments helped destroy the ether theory. In 1887, Michelson and Morley demonstrated that the earth's movement around the sun had no effect on the speed of light. Their finding could be understood only by assuming that the ether near the surface of the earth moved at the same speed as the earth. However, this assumption contradicted the results of many other experiments.

The contradiction was not resolved until 1905. That year, Albert Einstein analysed the measuring process itself and, as a result, proposed his special theory of relativity. The theory begins with two *postulates* (fundamental principles). The first postulate states that for all observers moving uniformly relative to each other, the laws of physics have the same form. The second postulate states that for all observers, the speed of light is *invariant* (has the same value). One conclusion from these postulates is that mass and energy are related. Einstein



**Sir Isaac Newton** of England stated laws of motion and gravitation during the late 1600's. He also demonstrated that white light is made up of all colours.

**Wilhelm Roentgen** of Germany discovered X rays in 1895. The use of X rays helped doctors diagnose illness and injury and revolutionized medicine.

**Marie Curie** of France made many advances in the study of radioactivity. In 1898, she and her husband, Pierre, isolated the radioactive element radium.

expressed this relationship in his famous equation $E = mc^2$. In this equation, $E$ stands for energy, $m$ for mass, and $c^2$ for the speed of light multiplied by itself.

Einstein also attempted to replace classical gravitational theories with a more exact statement of the laws of gravitation. In 1915, he announced his general theory of relativity. This theory begins by assuming that the effects of gravity on objects are identical to the effects of nongravitational forces acting on objects. Gravity is no longer viewed as a property of objects interacting with each other, but of objects interacting with space itself. The theory predicted that the path of a light beam will be affected by nearby massive objects. This prediction was confirmed in 1919. The theory also predicted the existence of *gravitational waves* that travel at the speed of light. However, these waves have not yet been detected. See **Relativity.**

**Uncovering the secrets of the atom.** The discovery that atoms have an internal structure prompted physicists to probe further into these tiny units of matter. In England, Ernest Rutherford developed a model of the atom in 1911. In this model, the dense positive charge resided in a small, spherical core called the nucleus, and the electrons travelled around this nucleus. Bohr proposed modifications of the model in 1913. That year, an American, Robert Millikan, obtained an accurate measurement of the electron's charge. See **Atom.**

The discovery of other subatomic particles continued after this early work. In 1932, James Chadwick, an English physicist, conducted experiments that suggested that the atomic nucleus was composed of two kinds of particles: positively charged protons and neutral neutrons. In 1935, Hideki Yukawa, a Japanese physicist, proposed that other particles, which he called *mesons,* exist in the atomic nucleus (see **Meson**).

In 1938, two German physicists, Otto Hahn and Fritz Strassman, discovered nuclear fission by splitting uranium atoms. Scientists quickly realized that, as Einstein's $E = mc^2$ formula indicated, the process of fission could liberate enormous quantities of energy. In 1942, during World War II, the Italian-born physicist Enrico Fermi and his coworkers at the University of Chicago achieved the first controlled fission chain reaction. In 1945, near the end of the war, American scientists and engineers produced the first bombs that relied on nuclear fission for their explosive power. Two such atomic bombs were dropped on Japan in August 1945. See **Nuclear energy** (The development of nuclear energy); **Nuclear weapon.**

**Advances in the mid-1900's.** After 1945, the picture of the atom grew more complicated as physicists discovered more and more subatomic particles. In 1955, the American physicists Owen Chamberlain and Emilio Segrè discovered the *antiproton* (a negatively charged proton). In 1964, the American physicists Murray Gell-Mann and George Zweig proposed the existence of *quarks* as fundamental particles. Protons and neutrons are composed of different combinations of quarks. Strong evidence for the existence of the quark resulted from the discovery of the *psi particle,* a type of subatomic particle also called the *J particle,* by the Americans Burton Richter and Samuel C. C. Ting. See **Antimatter; Psi particle; Quark.**

Research in the mid-1900's also led to important advances in technology. In 1947, American physicists invented the transistor. This tiny device revolutionized the electronics industry. In the early 1960's, researchers in atomic and optical physics produced light-amplifying devices called lasers. Lasers have become valuable tools in such areas as communications, industry, and nuclear energy research. See **Laser; Transistor.**

**Physics today.** Physics continues to be one of the most active and important sciences. Ongoing research into the nature of matter has led to important discoveries. For example, researchers in Germany discovered an important elementary particle, the *gluon,* in 1979. Gluons, which are a type of *boson,* carry the powerful *strong force.* This force, also called the *strong interaction,* binds the atomic nucleus together. In 1983, a

**Albert Einstein** proposed the special theory of relativity in 1905. It revised ideas of time and space and provided the basis for releasing the atom's energy.

**Niels Bohr** showed in 1913 that electrons circling the atomic nucleus give off or absorb quanta of energy by jumping from one orbit to another.

**Theodore H. Maiman** of the United States built the first laser, a ruby laser, and first operated it in 1960. A laser amplifies light into a powerful beam.

research team led by Carlo Rubbia of Italy discovered three more subatomic particles—the $W^+$ and $W^-$ *particles* and the $Z^0$ *particle.* Physicists predict that these particles are a source of the *weak force,* also called the *weak interaction.* This force controls the disintegration of atomic nuclei—the process at work in radioactivity.

Physicists believe that there may be an underlying unity among three of the basic forces of the universe: the strong force, the weak force, and the electromagnetic force that holds electrons to the nucleus. Theories that attempt to establish this underlying unity are referred to as *grand unified theories* (GUT's). Researchers are also testing *supergravity* theories, which would include the fourth fundamental force, gravitation. Such theories illustrate how physicists have again begun to express the hope that a few basic laws will unify all our knowledge about how the world works. See **Grand unified theories.**

Physics also continues to make important contributions to technology. For example, advances in electronics have resulted in the development of extremely sophisticated computers. Lasers and *optical fibres* (glass or plastic filaments that carry light) have led to improvements in communication systems and medical technology (see **Fibre optics**). Physicists have begun developing ceramiclike materials that can act as superconductors at much higher temperatures than the superconductors of the past. Advances in superconductivity could one day lead to such applications as efficient and economical power generators, high-speed trains that float on magnetic fields, and improved medical imaging systems.

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Planck, Max K. E. L.
Roentgen, Wilhelm C.
Stark, Johannes
Strassman, Fritz

**Italian physicists**

Avogadro, Amedeo
Fermi, Enrico
Galileo
Galvani, Luigi
Marconi, Guglielmo
Torricelli, Evangelista
Volta, Count

**Richard Feynman** contributed in the 1940's to the study of quantum electrodynamics, describing how electrons interact with electromagnetic radiation.


**Samuel C. C. Ting,** *above,* and Burton Richter of the United States discovered a new type of elementary particle—the *psi,* or *J, particle*—in 1974.

**Carlo Rubbia,** using the proton-antiproton collider at CERN, discovered in 1983 $W^+$, $W^-$ and $Z^0$ particles, confirming other scientists' predictions.

### Other physicists

Alfvén, Hannes O. G.
Basov, Nikolai G.
Bohr, Niels
Boltzmann, Ludwig
Gamow, George
Herzberg, Gerhard
Huygens, Christiaan
Kapitsa, Pyotr
Lorentz, Hendrik A.
Mach, Ernst
Meitner, Lise
Oersted, Hans C.
Pauli, Wolfgang
Piccard (Auguste)
Prokhorov, Alexander M.
Raman, Sir Chandrasekhara V.
Sakharov, Andrei D.
Schrödinger, Erwin
Siegbahn, Karl M. G.
Yukawa, Hideki
Zeeman, Pieter

### Atomic, nuclear, and particle physics

Alpha particle
Antimatter
Antineutron
Antiproton
Atom
Baryon
Beta particle
Boson
Cosmic rays
Crookes tube
Electron
Fission
Fusion
Gamma rays
Gluon
Hadron
Ion
Irradiation
Isotope
Lepton
Meson
Molecule
Muon
Neutron
Nuclear energy
Nuclear physics
Nuclear reactor
Nuclear weapon
Parity
Particle physics
Photon
Proton
Psi particle
Quantum electrodynamics
Quark
Radiation
Radioactivity
Transmutation of elements
Upsilon particle
X rays

### Electricity

See the **Electricity** article and its list of *Related articles.*

### Electronics

See the **Electronics** article and its list of *Related articles.* See also the following articles:

Electric field
Frequency modulation
Geiger counter
Kilohertz
Mass spectroscopy
Remote control
Short waves
Sniperscope
Teletypesetter
Transducer
Ultrahigh frequency waves
Van de Graaff generator
Very high frequency waves

### Heat

See the **Heat** article and its list of *Related articles.* See also the following articles:

Distillation
Dust explosion
Freezing point
Melting point
Pyrometry
Regelation
Spontaneous combustion
Sublimation
Superconductivity

### Light

See the **Light** article and its list of *Related articles.*

### Magnetism

See the **Magnet and magnetism** article and its list of *Related articles.*

### Mechanics

Adhesion
Aerodynamics
Antigravity
Ballistics
Bernoulli's principle
Capillarity
Cohesion
Dyne
Efficiency
Falling bodies, Law of
Foot-pound
Force
Friction
Gas
Gravity, Centre of
Horsepower
Hydraulics
Inclined plane
Inertia
Lever
Liquid
Manometer
Mechanics
Momentum
Motion
Osmosis
Pascal's Law
Pendulum
Pneumatics
Power
Pressure
Pulley
Screw
Siphon
Surface tension
Torque
Vacuum
Velocity
Viscosity
Wedge
Work

### Sound

See the **Sound** article and its list of *Related articles.*

### Other related articles

Astronomy
Dark matter
Geophysics
Grand unified theories
Gravitation
Interference
Matter
Quantum mechanics
Relativity
Shadow matter
Solar energy
Solar wind
Solid-state physics
Waves

### Outline

**I. What physicists study**
A. Mechanics
B. Heat
C. Sound
D. Electricity and magnetism
E. Light
F. Atomic, molecular, and electron physics
G. Nuclear physics
H. Particle physics
I. Solid-state physics
J. Fluid and plasma physics

**II. History**

### Questions

What is the difference between the work of a theoretical physicist and that of an experimental physicist?
What did Galileo demonstrate in his study of the motion of falling bodies?
When did physicists achieve the first controlled fission chain reaction? What was its significance during World War II?
What are some examples of developments in engineering and technology that involve the principles of physics?
What are grand unified theories? What distinguishes supergravity theories from grand unified theories?
What are the two postulates of Einstein's special theory of relativity?
What technological advances resulted from physics research in the mid-1900's? How have these advances been important?
How did Arabic scholars contribute to the development of physics during the Middle Ages?
What are quanta? Who first proposed the idea of quanta?
What did Michelson and Morley demonstrate in their 1887 experiment?

**Physiocrats** were a group of French economists who lived during the mid-1700's. They made important contributions to the development of economics as a social science. Their broad outlook and use of the scientific method made them the first modern thinkers in economics.

The physiocrats believed that land was the single source of wealth. They thought that only in agriculture could the value of products exceed the value of the materials used for their production. Physiocrats regarded industry and trade as necessary occupations, but ones that did not increase wealth in the same way as agriculture. Trade and commerce, they felt, changed only the form or location of wealth. Physiocrats opposed the mercantile system of tariffs and trade restrictions. Mercantilists thought that government should regulate economic activity to ensure that a country exports more than it imports (see **Mercantilism**). In place of tariffs, physiocrats proposed a single land tax. They supported *laissez faire* (freedom from government regulation).

François Quesnay was the leader and most important thinker of the physiocrats. He devised the *Tableau Économique,* a chart of the economy. This was the first attempt to picture a nation's economy as an interrelated series of institutions through which capital moves in a continuous cycle. See **Quesnay, François.** Anne-Robert-Jacques Turgot, a French finance minister tried to bring about reforms suggested by the physiocrats in 1774. Landowners objected strongly, however, and the influence of the physiocrats came to an abrupt end in 1776.

**Physiology** is the study of how plants and animals function. *Physiologists* (scientists who study physiology) investigate the various characteristics of living things. Their studies range from the most basic unit of organisms, the cell, to the more complex organs and organ systems, such as the brain and digestive system.

Physiologists study how different parts or organs of an organism work together to achieve a particular function. In human beings, for example, the digestion of food involves the action of hormones and other chemicals produced by the stomach, liver, and pancreas. Muscle contraction occurs through the action of chemical messengers produced by nerves that supply the muscle.

By learning how the body functions normally, physiologists and doctors are better able to understand what happens when organs function abnormally. For example, an understanding of how the thyroid gland functions has helped in the treatment of a condition called goitre (see **Goitre**). Studies of the circulatory system and of the nervous system have helped doctors understand and treat such illnesses as heart disease, stroke, and high blood pressure.

**Physiotherapy** is the use of physical means, such as light, heat, cold, and exercise, to treat disease or injury. Physiotherapy is used to help prevent, relieve, or correct conditions that interfere with a person's physical ability to function normally. Physiotherapy is administered by professionals called *physiotherapists.*

**Uses of physiotherapy.** Physiotherapy is helpful in treating many diseases and disabilities. It is often used in treating heart and lung diseases and various types of paralysis and muscle weaknesses, such as those arising from strokes and multiple sclerosis. It is also important in amputations, fractures and other injuries, and other orthopaedic conditions. With the aid of physiotherapy, a disabled person may lead a constructive life.

**Aids in physiotherapy.** Many kinds of equipment, exercises, and self-help devices are used to help the disabled person. Radiant heat lamps, electric heating pads, diathermy, hydrotherapy, and paraffin baths are used to apply heat. Heat relieves pain, improves circulation, and relaxes muscles. Cold, when used soon after injury, lessens pain, haemorrhage, and swelling. Ultraviolet radiation attacks germs and promotes healing of certain skin disorders. Ultrasound is used to treat inflammatory conditions of the joints, muscles, and nerves, and painful amputation stumps.

Exercise helps to maintain and improve body function and posture. It increases muscle tone, strength, and endurance. Some exercises can be performed by the patient alone. For others, the patient might need the help of the physiotherapist. Often mechanical devices, such as parallel bars, exercise bicycles, pulleys, weights, and dumbbells, are used. Self-help devices such as splints, braces, crutches, and wheelchairs help disabled people perform daily activities. Physiotherapists train people to use these devices and to develop confidence in accomplishing daily tasks.

See also **Bath** (Medical bathing); **Diathermy; Hydrotherapy.**

**Phytoplankton.** See **Ocean** (The plankton; The food cycle in the sea).

**Pi** is the ratio of the circumference of a circle to its diameter. This ratio is the same for every circle and is approximately 3.14159. It is represented by the Greek letter $\pi$ (pi).

Pi is used in a number of mathematical calculations. For example, the circumference *(c)* of a circle can be determined by multiplying the diameter *(d)* of the circle by pi: $c = \pi d$. Pi is also used to calculate the areas of circles and the volumes of spheres and cones. The area *(A)* of a circle is given by the formula $A = \pi r^2$, where $r$ is the radius. Many formulas that describe such physical phenomena as the motion of a pendulum or the vibration of a string include pi as well.

Pi is an *irrational number.* An irrational number cannot be written as a simple fraction or as a decimal with a *finite* (limited) number of decimal places.

See also **Circle** (The use of pi; History).

**Pi Sheng.** See **Invention** (China).

**Piaf, Edith** (1915-1963), a French singer and cabaret performer, won fame for songs of disenchanted love such as "La Vie En Rose" and "Non, Je Ne Regrette Rien."

She was born in Paris as Edith Gassion, the daughter of a noted acrobat. Abandoned by her mother in childhood, she became a street singer at the age of 15. In 1935, the slight young woman was renamed *Piaf* (sparrow) by a night club owner. In the late 1930's she appeared on stage in Jean Cocteau's *Le Bel Indifférent* and in several films, including Jean Renoir's *French-Cancan.*

Renowned for her dramatic cabaret performances, Piaf made many tours of Europe and the United States after World War II ended in 1945. In 1958, with her health declining, she published an autobiography, *The Wheel of Fortune.* Her comeback in 1961 led to further collapse and retirement.

**Many mechanical aids are invaluable in physiotherapy.** For a patient with arthritis, gentle use of a cycling machine helps to maintain joint mobility.

**Piaget, Jean** (1896-1980), a Swiss psychologist, won fame for his studies of the thought processes of children. He and his associates published more than 30 volumes on this subject.

Jean Piaget

Piaget believed that children pass through four periods of mental development. During the *sensorimotor period,* they obtain a basic knowledge of objects through their senses. It lasts until about the age of 2. During the *preoperational period,* from about 2 to 7, children develop such skills as language and drawing ability. In the *period of concrete operations,* from about 7 to 11, they begin to think logically. For example, they learn to organize their knowledge, classify objects, and do thought problems. The *period of formal operations* lasts from about 11 to 15. At this time, children begin to reason realistically about the future and to deal with *abstractions.* Abstractions are ideas about qualities and characteristics viewed apart from the objects to which they refer.

Piaget was born in Neuchâtel. When he was 10, he published a scientific article on an albino sparrow. He published articles on molluscs at 15. He received a doctor's degree in the natural sciences in 1918 and then studied psychology. In 1921, Piaget began to do research in child psychology at the Institute J. J. Rousseau in Geneva. He served as its codirector from 1933 to 1971 and as director of the International Bureau of Education from 1929 to 1967. Piaget was a professor of psychology at the University of Geneva from 1929 until his death. In 1955, Piaget founded the Centre for the Study of Genetic Epistemology, which studies learning processes.

**Piano** is a keyboard musical instrument in which sounds are made by strings struck by small padded hammers. A piano produces a greater range of musical sounds than most other instruments. On a piano, a musician can play melody and harmony at the same time. A pianist also can play an extraordinary variety of loud and soft notes with great speed.

A musician plays a piano by striking keys of the keyboard. The keys operate levers that move the padded hammers. The hammers strike tightly stretched metal strings, which are mounted on a frame. These metal strings vibrate and thereby produce different musical notes. The loudness of a tone depends on how hard the pianist strikes the keys.

The piano is important in many kinds of music. Most classical composers have written music for the piano as a solo instrument and in combination with other instruments or with singing. The piano is also used in jazz, rock, and other kinds of music.

### Parts of a piano

A standard piano has seven main parts: (1) strings, (2) keyboard, (3) action, (4) pedals, (5) frame, (6) soundboard, and (7) case. The case covers the strings, action, frame, and soundboard. The keyboard and pedals are attached to the outside of the case.

**The strings.** In almost all pianos, the strings are made of steel. Most pianos have more than 220 strings, each tuned to one of 88 notes. The strings range in length from 15 to 200 centimetres. They are arranged in ascending order of pitch from left to right by *semitones,* or *half steps.* The longest strings are lowest in pitch and form the *bass section,* which occupies the left side of the piano. The shortest strings are highest in pitch and form the *treble section,* which occupies the right.

The pitch of a note is determined mainly by the length of the strings. However, it also depends on the number, thickness, and *tension* (tightness) of the strings that produce each note. About 58 notes, called *unisons,* have three strings each, and almost all the rest have two strings. In most cases, heavy strings are used for the low tones, and light strings for the high ones. The tension of the strings is adjusted when tuning a piano. Loosening a string lowers the pitch, and tightening a string raises the pitch.

**The keyboard.** A standard piano keyboard has 88 keys. Like the strings, the keys are arranged according to pitch, in ascending order from left to right. On most pianos, 36 keys are black, and 52 are white. The black keys are shorter and thicker than the white ones. Most pianos have plastic keys. However, on some pianos, the white keys are made of ivory, and the black ones of ebony.

**The action** is an elaborate system of mechanical devices that transmit motion from the keyboard to the strings. The pianist starts the action by striking a key, which causes a system of levers to move a hammer. The hammer is made of wood and covered with a special kind of felt. The hammer strikes a string and immediately springs back off the string, allowing the string to vibrate and thereby produce a note. When the player releases the key, a device called the *damper* presses against the string and stops its vibration. If the pianist holds the key down, the damper remains off the string, allowing it to vibrate and produce a note. The action of a piano consists of about 4,000 parts, most of which are made of wood.

**The pedals** are located below the keyboard, at the bottom of the piano. They are used to vary the quality of tones played. The pianist operates the pedals with his or her feet. Most pianos have a *damper pedal* on the right and a *soft pedal* on the left. The damper pedal lifts all the dampers, allowing the strings that are struck to vibrate freely, even after the pianist has released the keys. The soft pedal shifts the hammers, which are arranged in a row. As a result, each hammer strikes one less string than it normally does, which softens and lightens the tone. Some pianos also have a *sostenuto pedal.* This pedal lifts the dampers from strings selected by the player.

**The frame.** A piano requires a strong frame to support the tremendous tension created by the stretched strings. The frame is made of cast iron. It withstands the strain of 220 strings exerting a total pull of from about 16,000 to 20,000 kilograms.

**The soundboard** is a thin sheet of wood that helps reinforce the sound created by the vibrating strings in a piano. The soundboard lies just below the strings and is made of a light wood, generally spruce. The wood vibrates with the strings, intensifying the sounds.

**Grand pianos,** such as the one shown above, are the largest and most expensive pianos. Performers use them in concerts.

**The case.** Most pianos have a wooden case, which covers the strings, action, frame, and soundboard. The case must be strong enough to support the weight of the piano.

## Kinds of pianos

There are four basic kinds of pianos: (1) grand pianos, (2) upright pianos, (3) player pianos, and (4) electronic pianos. The four types differ in size and construction and are used for different purposes.

**Grand pianos** are mounted on legs, and their strings and soundboard are parallel to the floor. The *concert grand* is the largest and most expensive piano. It measures about 2.7 metres long and is used in concert halls. The *boudoir grand* and the *baby grand* measure between 1.5 and 1.8 metres long and are suitable for homes.

**Upright pianos** are sometimes called *vertical pianos* because their strings and soundboard are perpendicular to the floor. These pianos take up less floor space—but also have poorer tone quality—than grand pianos.

**Player pianos** produce music automatically. They are operated by a roll of paper with patterns of holes that correspond to different notes. The roll moves over a cylinder, which also has small holes. A system consisting of a pump, bellows, and valves creates a vacuum in the cylinder. This vacuum sucks a stream of pressurized air through matching holes in the moving roll and the cylinder. The pressurized air causes the piano's hammers to move and strike the strings, producing music. Player pianos were popular during the late 1800's and early 1900's. The performances of many great pianists of that period have been preserved on player rolls.

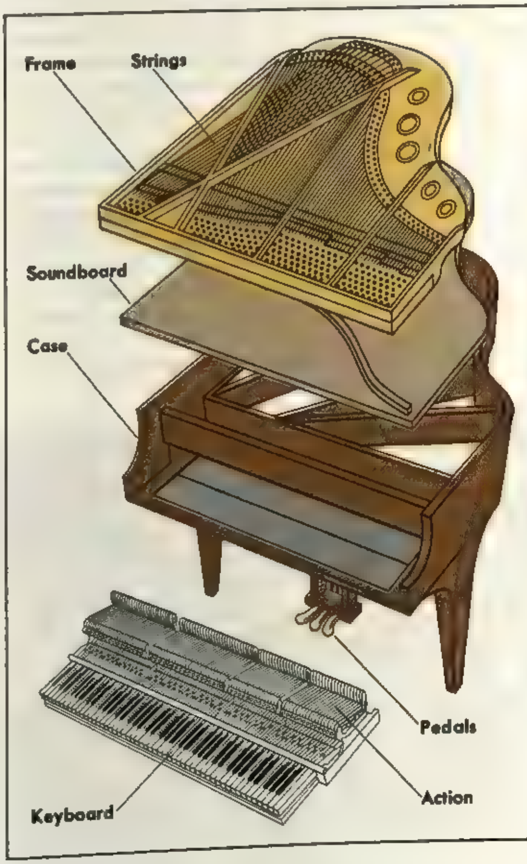
**Electronic pianos** are often used in jazz and rock music. In one kind of electronic piano, the sound of the hammer striking the strings is picked up by a microphone and amplified electronically. The most popular type has no strings at all. Instead, all sound is produced by electronic means. Both kinds of electronic pianos are small enough to carry, but they produce enough sound to fill a large auditorium. Both types have a keyboard. The number of keys ranges from 54 to 88.

## History

Several musical instruments, including the *dulcimer, clavichord,* and *harpsichord,* were forerunners of the piano. The dulcimer was probably invented in the Middle East during ancient times. It consists of a flat box with a set of wires across the top. The instrument is played by striking the wires with a mallet. The clavichord and harpsichord, which were developed by Europeans during the Middle Ages, were among the first string instruments with a keyboard.

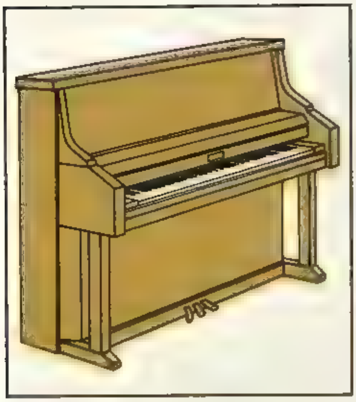
In 1709, Bartolommeo Cristofori, an Italian who built musical instruments, invented a keyboard instrument with strings that were struck by hammers. Cristofori gave his invention the name *gravicembalo col piano e forte,* which means *harpsichord with soft and loud.* The name was later shortened to *pianoforte.* Cristofori's instrument was the direct forerunner of the modern piano.

Between the late 1700's and early 1800's, several musical instrument makers improved upon Cristofori's original design. In the late 1700's, John Broadwood of England made many improvements to the piano. Broad-



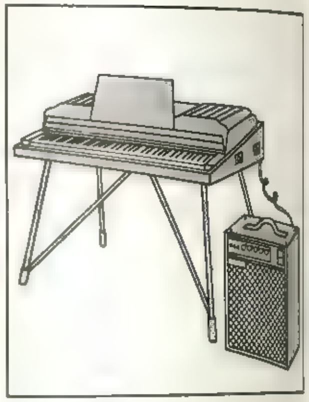

**A standard piano** consists of seven main parts. A wooden case encloses the frame, strings, soundboard, and action. The keyboard and pedals are attached to the outside of the case.

**Major kinds of pianos** Besides grand pianos, the main kinds of pianos are upright, player, and electronic pianos. Upright pianos are popular in homes owing to their small size. Player pianos produce music by means of a moving role of punctured paper. Electronic pianos produce music electronically.



**Upright piano**

**Player piano**



**Electronic piano**

wood's instruments produced louder and richer tones than their predecessors. In 1821, Sébastien Érard of France designed the *double escapement,* a device that improved the action of the piano's hammers. Alpheus Babcock, an American, invented a large cast-iron frame in 1825. He also developed a method of cross-stringing pianos. In 1855, Henry E. Steinway, a German-born piano maker who moved to the United States, combined all these inventions in one piano. His piano closely resembled the grand pianos built today.

Since the late 1700's, most great classical composers have written music for the piano. Leading composers of piano music before the 1900's included Ludwig van Beethoven, Johannes Brahms, Frédéric Chopin, Joseph Haydn, Franz Liszt, Wolfgang Amadeus Mozart, Franz Schubert, and Robert Schumann. Many classical composers of piano music, including Chopin, Liszt and Mozart, were also accomplished players.

During the 1900's, leading composers of piano music have included Béla Bartók, Claude Debussy, Paul Hindemith, and Maurice Ravel.

Some American composers introduced major changes in piano music. For example, Henry Cowell introduced groups of notes called *tone clusters,* which are played with the palm, fist, or forearm. Cowell also called for pianists to strum the piano strings with their fingers. John Cage devised the *prepared piano,* in which paper clips, drawing pins, and other objects are inserted between some of the strings. When the pianist strikes the keys for these strings, unusual sounds are produced. George Crumb electrically amplified the sound of the piano.

The leading pianists of the 1900's have included Vladimir Ashkenazy, Daniel Barenboim, Ferruccio Busoni, Van Cliburn, Glenn Gould, Dame Myra Hess, Vladimir Horowitz, John Lill, John Ogdon, Sergei Prokofiev, Sergei Rachmaninoff, Arthur Rubinstein, and Rudolf Serkin. A few pianists of the 1900's, including Busoni, Prokofiev, and Rachmaninoff, have also composed great piano music.

The Metropolitan Museum of Art, New York City,
The Crosby Brown Collection of Musical Instruments, 1889

**The pianoforte** was the earliest piano. Bartolommeo Cristofori invented it in 1709. He made the one shown above in 1720.

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**Piatigorsky, Gregor** (1903-1976), was a famous Russian-born cellist. His playing established him as one of the great cellists of his time. His collaborations in the 1960's with violinist Jascha Heifetz and violist William Primrose set the highest standards for chamber-music performance.

Piatigorsky was born in Ekaterinoslav (now Dnepropetrovsk), Ukraine, which was then part of Russia. He played with the Berlin Philharmonic from 1924 to 1928. He became a United States citizen in 1942, settling in Los Angeles. There, he taught master classes at the University of Southern California from 1962 until his death.

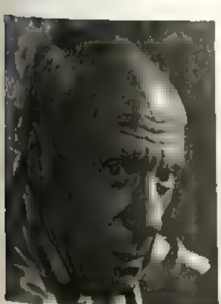
**Pica.** See Type (Sizes of type).

**Picador.** See Bullfighting.

**Picard, Jean.** See Metric system (History).

**Picaresque novel.** See Novel (Later European narratives); Spanish literature (The 1500's).

**Picasso, Pablo** (1881-1973), was the most famous painter of the 1900's. He also became known for his sculpture, drawings, graphics, and ceramics. In some ways, he was the artist most characteristic of the 1900's, because he responded to changing conditions, moods, and challenges so intensely and so rapidly. His searching style made him the leader in expressing the complexity of the 1900's.



**Pablo Picasso,** *left,* became a leading artist of the 1900's. *Guernica,* shown *below,* is considered one of his masterpieces. Picasso painted this symbolic work as a protest against the bombing of the Spanish town of Guernica.

Picasso's art challenges the viewer's traditional view of life. He appeared drawn to tension and conflict. Picasso seemed to explore the fantastic world of nightmare and deep imagination which modern psychology and modern art cite as great influences on our daily actions. He hoped to arouse and reveal unknown influences that lie hidden in the viewer's subconscious mind. His images radiate the strangeness of dreams, yet have the appearance of fact. Perhaps Picasso was influenced by the art of his native Spain, which often seems fascinated by the visionary and the monstrous.

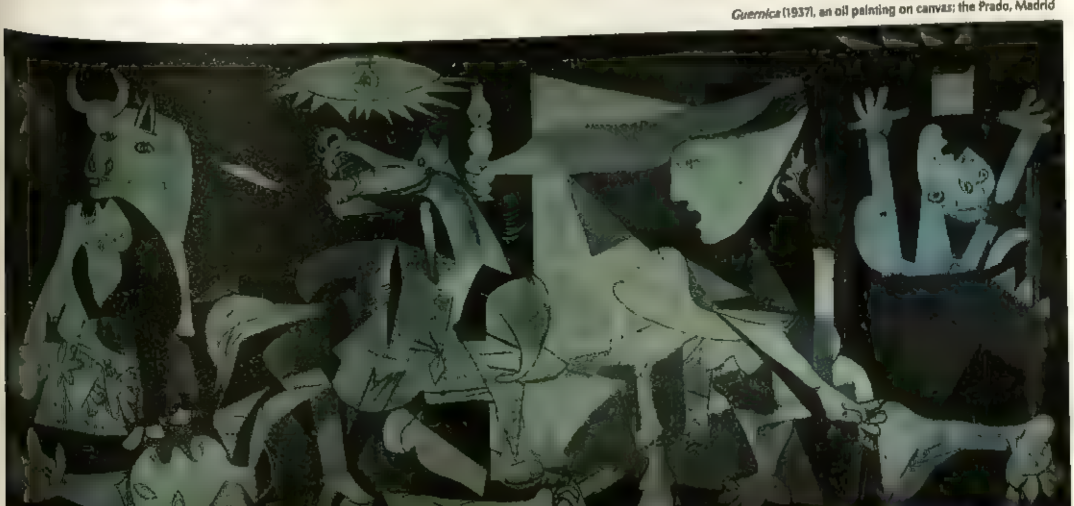
**Early career.** Picasso was born in Málaga, Spain, but lived in France from 1904 until his death. He was a child prodigy, painting realistic works when he was only 14 years old. Picasso's first personal style, called the *Blue Period* (1901-1904), focused on the themes of loneliness and despair, and featured mainly shades of blue. The style of this period gave way between 1904 and 1906 to a style that stressed warmer colours and moods. Abandoning the thin, discouraged faces of the Blue Period, Picasso gave his subjects new flexibility and frequently included circus scenes in his works. By 1906, he began painting great figures that are massive, as if to withstand potential shock or fear.

In 1907, Picasso painted *Les Demoiselles d'Avignon,* a landmark in art. This picture marked a decisive break with traditional notions of beauty and harmony. Five monstrous female figures with masks rather than faces pose in a convulsive, jagged array—distorted, shaken, and savagely transformed. Out of this disruptive image grew the style known as *cubism.* See **Cubism.**

Early in 1912, Picasso began including newspaper clippings, bits of debris, and stencilled words in his paintings. In this way he hoped to break down the distinction between art and nonart and to make viewers rethink their relationship to traditional art.

**Later career.** After World War I, Picasso extended

*Guernica* (1937), an oil painting on canvas; the Prado, Madrid



his explorations of form, placing special emphasis on brilliantly coloured dreamlike images. From 1918 to 1924, he painted in a classical style, with huge and stately figures. In the 1920's and 1930's, Picasso portrayed figures as though from the inside out, and the lifeless objects in these works appear to have a life of their own. His *Guernica* (1937) was painted as a protest against the bombing of the town of Guernica during the Spanish Civil War (1936-1939). The painting was Picasso's attempt to make a public statement using his personal symbols of rage and despair. The picture is a powerful expression of crisis and disaster beyond individual control.

In 1944, Picasso joined the Communist Party because he felt the Communists had been more effective in fighting the Nazis. But Picasso's art was officially condemned as "decadent" and "unacceptable" in most Communist countries.

After 1945, Picasso's painting, sculpture, and ceramics developed a more relaxed and gentle feeling. He appeared to make peace with the emotions that had tormented him so often in the past. Some critics feel this new Picasso had outlived the best days of his art. Others feel this represented another advance in Picasso's visual and mental adventures in art.

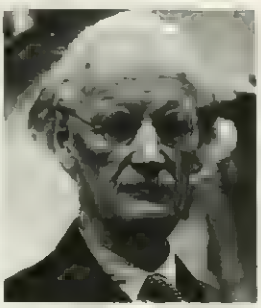
For other pictures of Picasso's paintings, see **Animal** (People and animals); **Colour** (Communicating with colour); **Don Quixote** (picture). **Painting** (The elements of painting).

**Piccadilly.** See **London.**

**Piccadilly Circus.** See **London** (Central London; picture).

**Piccard** is the name of a Swiss family of scientists who won fame in aeronautics and oceanography by designing and testing new high-altitude balloons and deep-sea diving vessels. Auguste and Jean Piccard, twin brothers, were born in Basel, Switzerland, and were educated in Zurich. Jacques Piccard, the son of Auguste, was born in Brussels, Belgium, and graduated from the University of Geneva.

**Auguste Piccard** (1884-1962), a physicist, invented an airtight *gondola* (passenger compartment) that he attached to a huge hydrogen-filled balloon. In 1932, he and an assistant, Max Cosyns, ascended in it 16,201 metres into the stratosphere and gathered information on cosmic rays (see **Balloon** [Manned explorations of the stratosphere]). In 1948, Piccard designed a deep-sea diving ship called a *bathyscaph* (see **Bathyscaph**). In 1953, he and his son, Jacques, descended 3,140 metres into the Mediterranean Sea in a bathyscaph named the *Trieste.* Piccard taught physics at the University of Brussels from 1922 to 1954. He then returned to Switzerland.

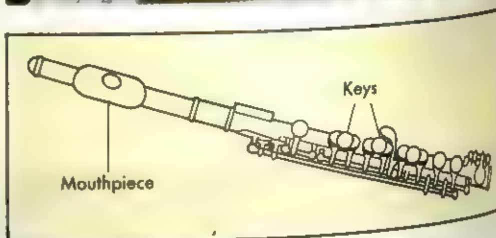


**Auguste Piccard**

**Jean Piccard** (1884-1963) was an aeronautical engineer and chemist. In 1934, he ascended by balloon more than 17,530 metres to study cosmic rays. In 1937, he made an ascent in an open gondola lifted by 98 balloons that measured 1.8 metres in diameter. This flight was the first manned ascent to use multiple balloons. Piccard became a U.S. citizen in 1931. He taught aeronautical engineering at the University of Minnesota, U.S.A. from 1936 to 1952.

**Jacques Piccard** (1922- ) is an oceanographic engineer. In 1960, in the bathyscaph *Trieste,* he and Lieutenant Don Walsh of the U.S. Navy descended 10,910 metres into the Pacific Ocean. In 1969, Piccard designed a special underwater craft for studying ocean currents. That year, he and five other scientists travelled in it along the Gulf Stream, a strong ocean current off the east coast of the United States. During the 1970's, Piccard studied the effects that pollution has had on ocean life. See also **Exploration** (picture: The bathyscaph *Trieste*).

**Piccolo** is the smallest of the woodwind instruments and the highest in pitch. It measures about 30 centimetres long. The piccolo is a member of the flute family. It is about half the length of the common concert flute and is played in the same way (see **Flute**). The piccolo sounds an octave higher than the concert flute, producing a bright, penetrating tone. The instrument is used in concert and military bands, and in orchestras. Piccolos were developed in the late 1700's and early 1800's in Europe.




**The piccolo** is the smallest of the woodwind instruments. A musician plays the piccolo like a flute, blowing across a hole in the mouthpiece while pressing keys that cover the tone holes.

**Pichincha,** a twin-cratered volcano, rises 4,784 metres in the Andes Mountains in north-central Ecuador (see **Ecuador** [map]). It last erupted in 1881. Climbers may ascend the peaks from Quito, about 8 kilometres to the southeast. On Pichincha's lower slopes, patriot forces defeated the Spanish royalists in the Battle of Pichincha in 1822, thus liberating Ecuador.

**Pickaroon.** See **Pirate.**

The **chain pickerel** is a popular freshwater game fish. It lives in lakes and streams in the eastern and southern United States.

**Pickerel** is the name given to three small North American members of the pike family. Like all pikes, true pickerels have large mouths and greedy appetites. They fight stubbornly when caught on a hook. All pickerels live in fresh water. They usually eat smaller fish.

The three kinds of pickerel are the *bulldog pickerel,* which is found from Massachusetts to Florida; the *mud pickerel,* which is abundant in the Mississippi Valley; and the *chain pickerel,* which lives in lakes and streams east and south of the Allegheny Mountains, from Maine to Florida and west to Arkansas. The bulldog pickerel and the mud pickerel seldom grow more than 30 centimetres long, and are too small to be important food or game fish. The chain pickerel is a popular game fish. Its flesh is good to eat. It commonly reaches a length of about 60 centimetres and may even reach an extreme size of about 90 centimetres. Its greatest weight is about 4.5 kilograms.

**Scientific classification.** Pickerels are in the pike family, Esocidae. The bulldog pickerel is *Esox americanus;* mud pickerel, *E. vermiculatus;* and chain pickerel, *E. reticulatus.*

See also **Pike.**

**Pickering, John.** See **Impeachment** (History).

**Pickering, Vale of.** See **Yorkshire.**

**Pickering, William** (1840-1907), a British public servant, became the first protector of the Chinese in Singapore in 1877. At that time, agents were recruiting *coolies* (labourers) in China and sending them to Singapore to work. Many agents treated the coolies badly, bringing them to Singapore in overcrowded ships and even sending them to other countries against their will. Pickering's job as protector was to stop this ill treatment. He was a man of strong personality and he could speak and read Chinese fluently. Under his leadership, the protectorate became a highly respected institution. As well as protecting both coolies and female immigrants, Pickering took action against Chinese secret criminal societies, and enforced strict regulations in order to control gambling.

William Pickering was born in Eastwood, in Nottinghamshire, England. In 1862, he joined the Chinese Maritime Customs and learned Chinese. He first went to Singapore in 1872 to work as an interpreter.

**Picket.** See **Strike.**

**Pickett, George Edward** (1825-1875), was a Confederate general in the American Civil War. His charge in the Battle of Gettysburg ranks as one of the great events in American history. On July 3, 1863, Cemetery Ridge was a key to the Union Army's positions. Pickett's division charged up the hill in the face of heavy fire, and his troops broke through a part of the Union lines. Soldiers fought hand to hand. No help came to Pickett from the main Confederate lines, and at last his men fell back, after suffering terrible losses.

**General George Pickett**

The failure of Pickett's charge ended the Battle of Gettysburg, and General Robert E. Lee retreated the next day. The charge and the battle marked the "high tide" of the Confederate cause. The battle shattered the Army of Northern Virginia, and it never regained its former power. Although Pickett continued in command of his division, he was broken in spirit. He later served with General James Longstreet.

Pickett was born in Richmond, Virginia, U.S.A., and graduated from the United States Military Academy in 1846. He served in the Mexican War and on the Indian frontier. Pickett became a major general in 1862, and fought in the Battle of Seven Pines and at Fredericksburg. After the Civil War, Pickett returned to Richmond and headed the Virginia agency of a New York insurance company.

See also **Gettysburg, Battle of.**

**Pickford, Mary** (1893-1979), was a star of silent films. Pickford became known as "America's Sweetheart" because of her great popularity. She was famous for her portrayals of plucky and innocent young heroines. Pickford made her screen debut in 1909 and appeared in 194 films. Among her most popular films were *The Poor Little Rich Girl* (1917) and *Rebecca of Sunnybrook Farm* (1917). Pickford won the 1928-1929 Academy Award as best actress for her performance in *Coquette.* She also received a special Academy Award in 1976 honouring her lifetime contribution to films.

**Mary Pickford**

Pickford was born in Toronto, Canada. Her real name was Gladys Marie Smith. She began acting on the stage at the age of 5. In 1919 she founded United Artists, a major Hollywood film studio, with director D. W. Griffith, and film stars Charlie Chaplin and Douglas Fairbanks, Sr. Pickford married Fairbanks in 1920. She retired from film acting in 1933.

See also **Fairbanks, Douglas, Sr.**

**Pickle** is a fruit or vegetable preserved in vinegar and salt. Pickles are made with or without sugar, and are usually seasoned with spices. Meats preserved in brine and vinegar are called pickled meats. Pickled pigs' feet and corned beef are prepared in a pickling solution, or brine.

The most common vegetable for pickles is the cucumber. Other fruits and vegetables often used in mak-

ing pickles or relishes are cauliflower, onions, tomatoes, beetroot, red and green peppers, cabbage, crab apples, peaches, pears, and watermelon.

In making most pickles, the fruits or vegetables are soaked in brine and vinegar. Then they are flavoured with seasonings such as mustard, dill, horseradish, cinnamon, allspice, cloves, celery seed, peppercorn, and pimento. The pickle is then sealed tightly in jars. Some firms prepare a mixture of many spices especially for use in making certain types of pickles. They call this product "pickling spice."

Cucumber pickles may be either sweet or sour. Dill pickles are the most common type of sour cucumber pickles. Small cucumbers, or gherkins, are the best known of the sweet type of cucumber pickle. Gherkins are preserved whole or in slices.

See also **Cucumber; Dill.**

**Picric acid** is an industrial chemical. Its name comes from a Greek word meaning *bitter;* a solution of the acid in water has a bitter taste. Peter Woulfe, a British chemist, first isolated the acid in 1771. Although best known as an explosive, picric acid is no longer used in shells because it corrodes the metal casings. It combines with metals to form salts called *picrates,* which are unstable and are used to set off more stable explosives. It also is used in electric batteries; in ointments for burns; and in dyeing textiles, etching copper, and manufacturing coloured glass.

Picric acid is a yellow crystalline solid, slightly soluble in water. It melts at 122° C. Its chemical formula is $C_6H_2(NO_2)_3OH$, and its technical name is *trinitrophenol.*

**Pictograph** is picture writing. Before the development of the alphabet, many ancient peoples conveyed messages by pictographs. The Egyptians carved or painted pictographs on tombs and monuments. Picture writing was also a means of communication for the Aztecs and for the early American Indians. Pictographs were of two kinds: those that represented objects, such as a drawing of the moon, and those that represented ideas, such as a drawing of a child with a book, to represent a student. Modern pictographs use pictures and words to tell a story better than words alone.

See also **Alphabet; Aztec** (Language; picture); **Graph; Hieroglyphics.**

**Picts** were an ancient people of northern Scotland. The Picts were given this name by the Romans because they painted or tattooed their skins. The Latin word for *painter* is *pictor.* The first historical reference to the Picts occurs in a speech made by a Roman orator in A.D. 297. The Pictish tribes fought the Romans for many years. The Romans built two long walls to keep the Picts out of the province of Britain. Later, the Picts fought the Teutonic conquerors of Britain, the Angles and Saxons. They disappeared as a people in about A.D. 900.

See also **Scotland** (The Romans and after).

**Picture.** See **Etching; Film industry; Painting; Photography; Poster.**

**Picture postcards** became popular as a cheap and rapid means of communication soon after 1900. The first plain postcard was issued in Austria in 1869, but no firm date can be given for the first picture postcard. This is because picture postcards gradually evolved, as ornamentation was added to plain cards. Originally, one side of a card was used for the message and the other side for the address and postage stamp. On the message side of cards, various small designs were sometimes used as decoration. These gradually became larger, until some cards had only a little space left for the message. A popular type of card from the 1890's bore greetings and scenes from a holiday resort. Cards became more and more attractive. Collecting cards developed into a craze around 1900, and publishers soon illustrated their cards with any design that might encourage sales.

In the early 1900's, changes in postal regulations resulted in a new look for postcards with the advent of the "divided back." A line divided one side of the card into message and address areas, so a picture could now occupy all of the other side.

The outbreak of World War I in 1914 marked the end of an era in picture postcard production. Until then, skilled German printers had produced quality coloured cards for distribution in many countries. After the war ended in 1918, postcards never regained their former popularity, because postal charges increased and the telephone gradually took over as the best means of rapid communication. However, although postcards were not used so much for everyday communication, they still proved popular with holidaymakers as a means of sending brief messages to friends and relatives.

The splendour of early picture postcards was rediscovered by many people in the 1970's, as collections made during the first postcard craze came onto the

**Mabel Lucie Attwell's postcards** are still popular today, although most postcards show scenic views.


**A postcard of the 1980's** in a traditional style shows the village of Winterborne Stickland, in Dorset, England.

market when their owners died. As a result, *deltiology* (collecting postcards) became popular once more.

Many collectors are interested only in high-quality early cards, and specialize in particular types. These include town and village scenes; patriotic war cards and political propaganda; railways, shipping, aviation and motoring; reproductions of advertising posters and famous paintings; stars of stage and cinema; exhibitions; royal events and personalities; and comic, greetings and novelty cards. Sales of early picture postcards are held by general and specialist auctioneers, and dealers can be contacted through collectors' magazines and at fairs, which are held regularly in many countries.

**Picture writing.** See Hieroglyphics; **Alphabet; Cuneiform; Pictograph.**

**Pidgin** is the most important *lingua franca* (common language) of Papua New Guinea. It is used as a second language by more than a million people. Pidgin is an independent language. About 65 to 70 per cent of the words in Pidgin are derived from English. Another 25 to 30 per cent of the words come from local languages, of which Tolai is the most important. About 5 per cent of the words come from German. There are a few words from Malay and Portuguese. But many words have been modified or have completely changed meanings. For example, the word *wantok* (one talk) means a person from your village who speaks the same language. See also Pidgin English.

**Pidgin English** is one of several *bridge* or *minimum* dialects, based on English, used in Asia and the South Seas between Westerners and Asians, and among peoples who have no common language. The word *pidgin* comes from a change in the pronunciation of the word *business.* Although sometimes viewed as a corruption of English, it serves the needs of millions who would be unable to communicate without it. The phrase *long time, no see* is Chinese Pidgin.

**Piece of eight** was a name for the Spanish *peso,* which corresponded to the American dollar. It was so named because it was worth 8 *reals* and once had an *8* stamped on it. It was sometimes cut into pie-shaped smaller denominations called *bits.* The most popular size was the quarter, called *two bits.* The United States quarter is sometimes called *two bits* today. The piece of eight was used when pirate activity was widespread. The coin figures in many pirate stories, including *Treasure Island* by Robert Louis Stevenson.

**Piecework** is a form of wage payment in which employees are paid a specified amount for each unit of satisfactory production. This system contrasts with *time wages,* in which an employee is paid for the amount of time worked. Piecework rates are designed to encourage employees to produce more in a given period.

Some piecework plans pay a premium over a certain level of production. Most pay a guaranteed minimum wage. Most plans have individual rates, but some pay for group output. Piecework is common in the manufacturing of clothing and electrical appliances.

**Pied Piper of Hamelin** is a mythical character who was made famous by Robert Browning in a poem based on a legend. According to the legend, the German town of Hamelin (now Hameln) was infested by rats. One day, a man dressed in a suit of many colours walked into Hamelin and offered to rid the town of the pests for a sum of money. When the mayor agreed, the man drew out a pipe and walked along the streets playing a haunting tune. All the rats came tumbling out of the houses and followed the Piper to the Weser River, where they drowned. When the Piper claimed his reward, the mayor refused to pay him. The Piper swore vengeance. Once more he walked along the streets playing his strange melody. This time all the children ran from their homes and followed him to a cave in the nearby Köppen Hill. The cave closed upon them, and the children were never seen again.

Mural (1909) by Maxfield Parrish; Pied Piper Bar, Palace Hotel, San Francisco, U.S.A.

**The Pied Piper** bewitched the children of Hamelin by playing a haunting melody on his pipe. He led them out of town and into a cave, which closed behind them. They were never seen again.

This legend seems to be based at least in part on fact. Old writings on the walls of several houses in Hamelin say that on July 26, 1284, a Piper led 130 children out of town and that they were lost in Köppen Hill. Some believe that the Piper was an agent of the Bishop of Olmütz who in the late 1200's drew many Hamelin lads to Moravia, where they settled. Others claim robbers kidnapped the children. It is also possible that the legend came from the Children's Crusade of 1212.

**Piedmont** is a territorial region of Italy in the upper valley of the Po River. For location, see **Italy** (political map). The name *Piedmont* means *foot of the mountain.* It refers to the region's position at the base of the Alps. The region includes the provinces of Alessandria, Asti, Cuneo, Novara, Torino, and Vercelli and has about 4½ million people. Its capital is Turin. Farming is the chief industry. Piedmont was once part of the Sardinian kingdom (see **Sardinia, Kingdom of**). Piedmont was the centre of Italian nationalism in the 1800's, and its ruler Victor Emmanuel II became the first king of Italy in 1861.

**Piepoudre, Court of,** also spelt *piepowder,* was a medieval English court that settled disputes among pedlars and tradespeople at fairs and markets. The court got its name from the Norman French words *pieds puidreaux (powdery feet),* which referred to the dusty feet of the pedlars. Norman French was the official language of the courts. Courts of piepoudre were private courts and the profits from them went to the people authorized to hold them. They became obsolete in the late 1700's.

**Pier** has two meanings. One kind of pier is a pillar or platform built as a foundation for a heavy structure. Such piers may form the supports for adjacent spans of a bridge or the foundation posts of a building. Construction companies use huge drilling machines to excavate circular shafts to make piers for tall buildings such as skyscrapers, and sometimes drill down 30 metres or more. Most modern piers are made of concrete.

Another kind of pier is a platform on posts or piles which stretches out over water from the shore. These piers are for mooring boats and ships while they are loading or unloading cargo or passengers. Some large piers built at seaside holiday resorts on tidal waters have buildings on them and are used for recreational purposes. Such piers also provide holidaymakers with a promenade and a deck from which to fish even when the tide is out.

**Pierce, Franklin** (1804-1869), was president of the United States from 1853 to 1857. He led the country during one of the most prosperous periods in U.S. history. However, it was also a time of increasing bitterness between North and South that later led to the American Civil War (1861-1865). Pierce faced growing Northern opposition to any expansion of slavery.

Pierce was born in Hillsboro, New Hampshire, U.S.A. A Democrat, he served as a U.S. representative (1833-1837) and senator (1837-1842). In 1847, during the Mexican War, he served as a brigadier general. As president, he supported the Kansas-Nebraska Act, which made slavery possible in a large area of the West.

**Pierneef, Jacob Hendrik** (1886-1957), was one of South Africa's most successful artists. He was born in Pretoria of Dutch parents. He was deported by the British in 1900 during the Second Anglo-Boer War (1899-1902). Pierneef then studied art at Rotterdam Art Academy in the Netherlands. After the end of the war, he returned to Pretoria, where he lectured in art at the Pretoria and Heidelberg Teachers Colleges.

From the mid-1920's, Pierneef began to adopt a geometric style. In 1930, he began work on a series of murals for Johannesburg railway station. In 1932, he was commissioned to execute works for South Africa House in London. In 1936, the South African Academy awarded him the Medal of Honour.

**Piero della Francesca** (1420?-1492) was an Italian Renaissance painter. Piero favoured calm, restrained figures in clear, simple spaces. His paintings combine precise contours and carefully created illumination with sensitive colour and harmonious design. In the *Baptism of Christ,* Piero painted early morning light over a quiet landscape to set a gentle, dreamlike mood. This painting is reproduced in the **Jesus Christ** article. Piero's most famous work is the series called *The Legend of the True Cross,* painted in *fresco,* which means it was painted on damp plaster. In one episode, *The Dream of Constantine,* Piero achieved dramatic effects with his use of bright artificial light and deep shadow.

Piero was born in Sansepolcro, near Arezzo, Italy. In Florence, Piero learned how to paint in the new Renaissance style of the artists Masaccio, Fra Angelico, and Domenico Veneziano. He also learned the construction of perspective, which fascinated him throughout his life. From Domenico Veneziano in particular, Piero acquired skill in the treatment of light and delicate colour.

See also **Easter** (picture: The Resurrection).

**Piers Plowman.** See **Langland, William.**

**Pietermaritzburg** (pop. 156,473; met. area pop. 211,473) is the capital city of Kwazulu-Natal province in South Africa. It lies 77 kilometres from Durban. See **South Africa** (political map).

The city is located in the Natal Midlands. It is 676 metres above sea level. It enjoys a pleasant climate, with average maximum temperatures of 25 °C and average minimum temperatures of 11 °C.

Pietermaritzburg is known as the "city of flowers" because of its many parks and gardens. It is also famous for its unique Victorian and Edwardian architecture. The city has 24 proclaimed national monuments. The city hall, built in 1900, is the largest brick building south of the equator.

Pietermaritzburg was established in 1838 as a capital for *voortrekker* (people involved in the Great Trek). See **Great Trek.** It was named after two prominent trekker leaders Piet Retief and Gerhardus Maritz.

See also **Natal.**

**Pietersburg** (pop. 25,500) is the capital city of Northern Province in South Africa. It lies about 250 kilometres northeast of Pretoria, on the main road connecting Johannesburg with Zimbabwe. For location, see **South Africa** (political map).

Pietersburg is an important industrial, administrative, commercial, and agricultural centre. Industries include processed meat, processing of asbestos and other minerals, dairy products, and fruit juice. The surrounding area has some of the most prosperous cattle ranches in South Africa. Other agricultural produce include alfalfa, coffee, flowers, fruit, maize, peanuts, potatoes, and sorghum.

The city was founded by *voortrekkers* (pioneers) in

1886 and named after General Piet Joubert. For a time during the second Anglo-Boer War (1899-1902), it was the capital of both Transvaal and Orange Free State.

**Piezoelectricity** is an electric phenomenon that occurs in certain nonmetallic minerals, such as quartz, Rochelle salt, and tourmaline. These crystals develop an electric charge on their surfaces when they are stretched or compressed along an axis. In addition, voltage applied to such crystals causes them to expand and contract, producing vibrations. Crystals that have these properties are called *piezoelectric crystals.* Pierre and Jacques Curie, two French physicists, published their discovery of piezoelectricity in 1880.

Piezoelectricity has many important uses. For example, piezoelectric crystals control the frequency of electric current in radio transmitters. The crystals are carefully cut so that they *resonate* (ring or echo with sound) only at signals of a certain frequency. Piezoelectric crystals in a record player's pickup cartridge convert the vibrations of the needle into a varying electric signal. Piezoelectric crystals are also used in microphones and other electronic devices that change sound waves into electric signals.

See also **Quartz.**

**Pig.** About a quarter of the meat eaten in the world comes from pigs. These animals provide pork, which is eaten as pork chops, ham, bacon, and sausage. The fat, skin, hair, glands, and other parts of pigs are used to make lard, leather, brushes, soap, fertilizer, glue, medicines, and many other products.

Farmers in almost every country raise pigs. Both young and adult pigs are also called *hogs* or *swine.* Young pigs are almost always called *piglets.* Farmers who raise pigs for meat are sometimes called *pork producers.* Pigs are among the most intelligent of the *domesticated* (tamed) animals. Some people consider them dirty, yet pigs keep themselves cleaner than most other farm animals do. However, during warm weather, pigs often *wallow* (roll about) in mud to keep cool.

There are about 840 million pigs on farms throughout the world. China has the most pigs, about 40 per cent of the world total. The United States ranks second in pig production. Brazil is the largest producer of pigs in South America.

In many parts of Europe, particularly countries around the Mediterranean and in Eastern Europe, pigs are generally raised on small farms. The pig is a suitable animal for small farms because many pigs can be kept on little land. A steady income can be obtained from selling the piglets after they have begun to eat solid food. Some farmers fatten pigs for pork and bacon. Others concentrate on producing breeding stock.

**Pigs** are a major source of income for farmers in many countries. This photo shows a Yorkshire sow nursing her piglets.

**Pig farming** is an important part of China's economy. China has more pigs than any other country in the world.

Selective breeding, better housing, and more nutritious feeds have resulted in improved pigs. Pigs today grow faster on less food and produce more lean meat and less fat than did pigs raised in the past.

Maize is one of the principal ingredients in pig feed in the United States, where the main area of pig production is the Midwestern States. This area produces three-quarters of the country's entire maize crop.

In Europe, barley is used for pig feed. In countries with large dairy industries, such as Denmark, much skimmed milk is available for feeding pigs. Danish farmer cooperatives process pigs from individual farms. They also market bacon and ham. The cooperatives lay down standards for pig breeding and feeding.

## Kinds of pigs

There are many kinds of pigs raised around the world. Because pigs have a short reproduction cycle, new breeds can be developed over a relatively short period of time. Often, such breeds reflect the climate and production methods of the region in which they are raised. In Europe, for example, each country has developed its own breeds of pigs. In North America, regional differences among breeds of pigs are slight.

### Pig terms

**Barrow** is a male pig whose reproductive organs have been removed by an operation.
**Boar** is a male pig of any age.
**Farrow** means to give birth to piglets.
**Gilt** is a female pig usually less than 1 year old that has not given birth to piglets.
**Herd** is a group of pigs.
**Litter** is the group of piglets that a sow gives birth to at one time.
**Piglet** is a young pig.
**Pork** is the flesh, or meat, of pigs.
**Shote,** or **shoat,** is a piglet about 8 weeks old that has been *weaned* (taken off its mother's milk).
**Sow** is an adult female pig.
**Swine** is another name for pigs.

Farmers in many countries raise chiefly *crossbred* pigs. Crossbred pigs are produced by mating parents of different breeds. Crossbreds, also called *hybrids,* are more active at birth, grow more rapidly, and have higher reproduction rates than purebreds.

*Meat-type* pigs produce more lean meat in proportion to fat. Pork from such pigs is low in fat and is a good source of high-quality protein.

**Main breeds.** Common breeds of pigs in Europe and North America include the Large White and Landrace. All the best European and American breeds owe their quality to the introduction of British stock. The excellence of Danish bacon owes much to the Large White, also known as the Large White Yorkshire, which is related to the Yorkshire breed raised in the United States. Piétrain is a muscular breed of pig found in Belgium, Luxembourg, and the Netherlands. The eight breeds of pigs commonly raised in the United States are the American Landrace, Berkshire, Chester White, Duroc, Hampshire, Poland China, Spotted Swine, and Yorkshire. There are about 40 breeds of pigs in China. Domestication of pigs began earlier in China than anywhere else. The movement to improve pig breeds began in Britain in the 1700's, when pigs were imported from China to improve the size and fatness of the native breed.

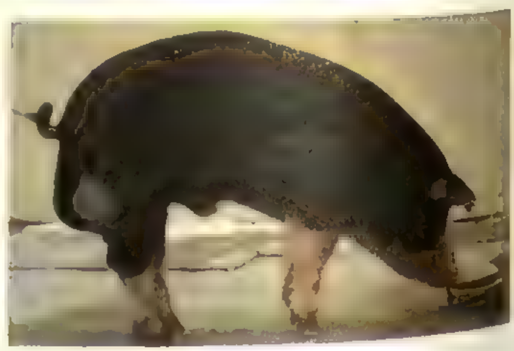
**Wild pigs** are strong, fierce animals that live in forests and jungles in many parts of the world. They include the babirusa, or babirussa, of the East Indies; the wart hog of Africa; and the wild boar, which lives in some parts of Europe, Asia, and Africa.

The European *wild boar* has survived in a number of countries, including France, Germany, and Italy, though

**The American Landrace is a long-bodied pig.**

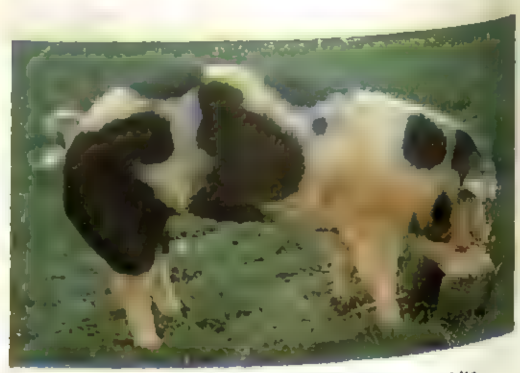
**The Hampshire was developed in the United States.**

**Berkshires provide meat with little excess fat.**



**Poland Chinas are often used for crossbreeding.**

**Chester Whites must have shade to avoid sunburn.**



**Spotted Swine may be mostly black or mostly white.**

it is now rarely seen in the wild. The commonest species is *Sus scrofa.* It is larger than the domestic pig and much stronger and faster. It was common in the United Kingdom before the 1700's, when it died out as a result of over-hunting.

Wild pigs called *razor-backs* (because they have sharp, narrow backs) live in the Southeastern United States and the West Indies, and in Australia. They are descended from domestic pigs that escaped from farms and became wild again. The Australian razor-back is black and has a massive head and shoulders, a raised and prominent backbone, and a straight tail. It is now rare, except in parts of northern Australia. There are also wild pigs in New Zealand. They are descended from domestic pigs that were released by the British explorer, Captain James Cook.

**Main breeds of pigs**

| Breed | Place and date of origin | Identifying features |
|---|---|---|
| American Landrace | Indiana, U.S.A., 1930's | White; drooping ears; long body |
| Berkshire | England, 1700's | Black with white markings; erect ears; short snout |
| Chester White | Pennsylvania, U.S.A., early 1800's | White; drooping ears |
| Danish Landrace | Denmark, late 1800's | White; drooping ears |
| Duroc | New York, U.S.A., early 1800's | Red; drooping ears |
| Hampshire | Kentucky, U.S.A., early 1800's | Black with white band around shoulders and front legs |
| Large White | England, 1700's | White; erect ears |
| Piétrain | Belgium, early 1900's | Dirty white with black or reddish spots; semidrooping ears |
| Poland China | Ohio, U.S.A., late 1800's | Black with white markings; drooping ears |
| Spotted Swine | Ohio and Indiana, U.S.A., late 1800's | Black and white spotted |
| Yorkshire | England, early 1800's | White; erect ears |

**Durocs** are a popular breed of pig because they produce large litters and gain weight rapidly.

Peccaries are wild, piglike animals that live in parts of North and South America. They are not true pigs.

## How we use pigs

**Food.** People in many countries eat the meat of pigs as pork chops, spareribs, loin roasts, ham, bacon, and sausage. Popular sausages made from pork include wieners, bologna, bratwurst, mettwurst, braunschweiger, and salami. Some pig meat, such as pig's feet and knuckles, is pickled. *Chitterlings* (fried pig intestines) and fried pig skin are popular foods in some countries. People also eat such pig parts as the stomach, kidneys, liver, ears, brain, snout, jowls, lips, tongue, and throat. Lard used for cooking is made from pig fat. Some religions, such as Islam and Judaism, forbid their followers to eat pork because they regard pigs as unclean.

**Other uses.** Tanneries process the skins of pigs into leather used for such products as belts, gloves, jackets, and shoes. The hair of the pig provides bristles for brushes. It is also used to stuff mattresses and to make insulating materials. Pig blood is used to make animal feeds, fertilizer, and medicines. Pharmaceutical firms make insulin, ACTH, and other medicines from pig glands. Pig fat is made into lard, soap, candles, salves, shaving cream, explosives, and lubricating oils. The bones of the pig are ground for glue, fertilizer, animal feeds, and bone oil.

## The bodies of pigs

The pig has a stout, strong body covered with coarse, bristly hair. The head and short, thick neck extend in a straight line from the body. The head ends in a snout. The pig's thick skin has no sweat glands to serve as a cooling system. Pigs like to wallow in mud because it helps them keep cool. Pigs have small eyes and poor eyesight. But a keen sense of smell helps them find food. They have a short tail that is usually curled. Pigs grunt. They squeal when hurt or excited.

**Size.** Pigs weigh about 1 kilogram at birth, and usually double their weight in the first week. When fully grown, *boars* (males) may weigh more than 230 kilograms and *sows* (females) more than 200 kilograms. The average adult boar weighs from 160 to 230 kilograms and the average adult sow from 140 to 200 kilograms. Most pigs are sold when they are 6 to 7 months old and weigh from 95 to 115 kilograms. Pigs kept longer are usually used for breeding.

**Snout.** The pig's snout has a broad, leathery pad that includes the nostrils. The snout is very sensitive to touch. Pigs often use their snouts to root, or dig, for vegetable roots, one of their favourite foods.

**Teeth.** Pigs have a total of 34 or 44 teeth, depending on the species. Eight of these are *canine teeth* (pointed teeth) that often develop into sharp tusks, particularly in adult boars. These tusks serve as tools for digging and as weapons. Farmers may clip the tusks off mature boars because they can cause injury. A pig protects itself by running away. But if cornered, it may charge and bite.

**Feet.** The pig has four toes on each foot. Each toe ends in a hoof. The two middle hoofs are divided on all pigs except the Mule-Foot breed. Mule-Foot pigs have a solid, or single-toed, hoof in the middle of each foot. The two other toes on each foot do not touch the ground when the pig stands.

**A pig farm** has outdoor pens, called *sties,* where the animals eat and exercise.

**Life history.** Pigs reproduce rapidly and can be mated when about 8 months old. Sows carry their young about 114 days before *farrowing* (giving birth). Sows usually give birth to 8 to 12 piglets at a time, but the number may range up to 27 or more. Pigs reach full growth at 1½ to 2 years of age and can live from 9 to 15 years.

## Raising pigs

**Feeding.** Farmers provide pigs with well-balanced diets. Carbohydrates from maize and such grains as sorghum, barley, wheat, rye, and oats provide energy. Meals made from soybeans, linseed, cottonseed, peanuts, fish and meat scraps, skimmed milk, and *tankage* supply proteins. Tankage is a feed made from the bones, tendons, and other parts of animals. Pigs need several kinds of minerals, especially salt. Alfalfa and other pasture crops supply vitamins. However, such crops, also called *forages,* are difficult for pigs to digest. *Additives* are substances that are added to pig feeds to increase growth and improve health.

**Shelter.** There are two general methods of housing pigs. One method is to house them in buildings and in concrete yards. The other is to keep the pigs in open *pens,* called *sties,* or pastures. Such sties may feature several small pig houses. Most young pigs spend their first few months in buildings, and later are moved to a sty. However, many pork producers keep all of their pigs in buildings.

**Diseases.** The most common diseases that attack pigs include respiratory infections, flu, and digestive disorders that cause diarrhoea. *Mange* is a skin disease caused by tiny organisms called *mites* that burrow into the pig's skin. Pigs also may become infected with lice. Farmers kill mites and lice by spraying pigs with insecticides. Pork infected with *trichina worms* can cause trichinosis in people who eat the pork. Thorough cooking of pork kills trichina worms.

**Farrowing.** A few days before a sow farrows, the farmer washes it and places it in a clean pen. The farmer must take special care to prevent the sow from crushing its young when it lies down. Many pork producers use farrowing stalls that confine each sow to a small space, but allow the piglets to move about. Farmers usually provide the piglets with a heated sleeping area. In addition to keeping them warm, the heat attracts the piglets and keeps them out of the sow's way.

Sows usually nurse their young for 3 to 5 weeks. After the piglets are *weaned* (taken off their mother's milk), they are fed a diet rich in protein. During this period, the piglets are kept in houses called *nurseries.*

**Marketing pigs.** In the past, pigs were farrowed only during seasons with mild temperatures, generally spring and autumn. Modern production methods now enable pork producers to farrow and market pigs throughout the year. This practice provides a constant supply of pork products to consumers and makes better use of production facilities.

Some pork producers sell their pigs directly to a meat-processing plant. Other pork producers sell the animals through a broker or at a livestock auction. Still other farmers ship their pigs to a central market for sale at a later date.

## History

Wild pigs roamed throughout Europe and other parts of the world as long as 6 million years ago. Scientists believe people began taming pigs about 8,000 years ago, during the Stone Age. Explorers and colonists from Spain, England, and other countries brought pigs to North and South America in the early 1500's. Pigs were introduced into Australia and New Zealand in the late 1700's.

**Scientific classification.** Pigs belong to the pig family, Suidae. The European wild boar, from which domestic pigs are largely descended, is *Sus scrofa.*

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| Boar, Wild | Meat | Wart hog |
| Brucellosis | | |

**Pig iron.** See Cast iron; Iron and steel (Kinds of iron and steel).

**Pigeon** is any bird in the pigeon and dove family. The larger members of the family are usually called *pigeons* and the smaller ones *doves.* In this article, the term *pigeon* refers to both pigeons and doves.

There are about 300 *species* (kinds) of pigeons. These birds live in all parts of the world except extremely cold regions, but most species live in tropical climates. For example, 24 species of pigeons make their home in Mexico. Only 3 species are found in their natural surroundings in Canada. Huge populations of feral pigeons are seen in cities in Europe, America, and Asia. They are descended from domesticated rock doves.

## The body of a pigeon

Pigeons have a plump body; a small head; and short, sturdy legs. They are swift, powerful fliers and have large flight muscles in their chests. Their feathers are stiffer and smoother than those of most other birds. The

texture of a pigeon's feathers may smooth the flow of air around the bird's body during flight. Some kinds of pigeons have specially shaped feathers that may help them fly at speeds slower than normal. Other species have feathers that produce certain sounds during flight. The pigeons communicate with one another by means of these sounds.

Most species of pigeons measure from about 25 to 38 centimetres long. Most species have dull-coloured feathers that are black, blue, brown, or grey. The males and females of most species look much alike, but the males are a little larger and brighter. Some species, such as the *Asian fruit pigeon* and the *bleeding-heart pigeon* of the Philippines, rank among the most beautiful birds in the world. These birds have bright markings on the front parts of their body. A pigeon may use its markings to attract a mate or to threaten other pigeons of the same species that approach its nest or territory.

Pigeons drink in an unusual way. They do not tip their head up with each sip, as most birds do. Pigeons thrust their beak into the water and suck the liquid through it as though it were a straw.

## The life of a pigeon

Most pigeons build their nests in trees. But one species, the *rock dove,* nests on rocky cliffs or on the lower ledges and sills of buildings. Other species, called *ground doves,* build their nest on the ground.

Pigeons begin to look for food and water early in the morning. They generally rest during part of the afternoon and then seek more food and water. The birds return to their nests before nightfall.

Most kinds of pigeons live in the same region throughout the year. However, many species that live in cool regions migrate in large flocks during the autumn and spring. People often shoot the pigeons during these migrations.

**Food.** Pigeons eat fruits, grains, and nuts, and they sometimes feed on insects, snails, and worms. Some species obtain food by pecking at the ground. Others do not usually land on the ground, and so they feed in trees.

**Flocks.** Most species of pigeons live in flocks, and many of the flocks consist of more than one species. The large number of birds in a flock increases the chances of finding food. The flocks also provide protection against such enemies as cats, hawks, martens, owls, and rats. Some pigeon flocks include other species of birds, such as blackbirds and sparrows. The presence of these birds further improves the chances of locating food and of being warned of danger.

**Life history.** Many scientists believe that a male and female pigeon mate with each other for life. Most other kinds of birds mate with different partners. During courtship, the male pigeon bills and coos to the female while the female watches him. The two birds smooth each other's feathers, and the male feeds the female a few seeds. The courtship goes on for a few days, after which mating occurs.

Pigeons build a fragile nest of twigs and grass. The female usually lays two white eggs. The parents take turns sitting on the eggs, which hatch in about 17 days. The young are born blind and almost featherless. They grow rapidly and can fly in four or five weeks.

Both parents feed the newly hatched young a white liquid called *pigeon's milk.* The milk is produced in the *crop,* a space in the throat of the parents. They feed the babies by pumping the milk down the throats of the youngsters. The young begin to eat solid food after about 10 days.

Most pigeons that survive the first few months live from three to five years. The larger species live longer than the smaller ones.

## Kinds of pigeons

There are two main groups of pigeons, wild and domestic. Domestic pigeons are bred by people.

**Wild pigeons.** Of the nearly 300 wild species, some of the best-known are the wood pigeon, the collared dove, the rock dove, and the mourning dove.

In many parts of Europe, the wood pigeon is one of the commonest agricultural pests. It is a handsome, strongly-built bird. The adult wood pigeon can be distinguished from other pigeons by the white patch on the sides of its neck. Wood pigeons also have a white band across their wings.

The collared dove, which originated in the Far East, is well known for its spread across Europe during the 1900's. This elegant bird has a greyish-fawn colour above and a paler colour on the underneath. It has a

**Pigeons** are common in most large cities. They usually build their nests with loose-fitting sticks. The male, *right,* and female, *left,* both help raise the young.

pinkish colour on the breast. The narrow, black collar on the back of its neck is edged with white.

The rock dove nests on cliffs in Africa, Asia, and Europe. It is dark blue and has two black stripes on its wings, a white rump, and a black band on its tail. The feathers on its neck are glossy green and purple.

The mourning dove is the most common of the smaller North American wild pigeons. It makes a sad, cooing sound and is well known as both a game bird and songbird. Another American game bird, the *passenger pigeon,* became extinct in the early 1900's, largely because hunters had killed so many of the species.

Crowned pigeons, the largest of all pigeons, live in New Guinea. They rank among the most beautiful pigeons. These birds have a variety of colours, and tufts of thin, lacy feathers form a crest on their head. The brightly coloured fruit pigeon is found in Asia and on Islands in the South Pacific Ocean. Its nest is so flimsy that the female must hold her eggs and the nest in place if even a slight wind blows. The bleeding-heart pigeon, which lives in the Philippines, has white underparts except for a bright red spot on its chest.

**Domestic pigeons.** Scientists believe that most breeds of domestic pigeons are the descendants of wild rock doves. Many of these birds differ greatly from their wild ancestors. But if a domestic pigeon becomes wild, its descendants after several generations resemble their wild ancestors. For example, city pigeons, which are wild descendants of a number of domestic breeds, resemble wild rock doves.

People probably began to breed pigeons thousands of years ago. Through the centuries, breeders have developed many types of pigeons for various purposes. Pigeons have been bred to serve as a source of food, to carry messages, or for racing, recreation, or show.

People use *homing pigeons* to carry messages and for racing. These pigeons have a remarkable ability to find their home loft from great distances. *Carrier pigeons* are also used to carry messages. These large, swift birds have fleshy growths of skin called *wattles* around their beak and eyes.

Pigeon shows feature specially bred varieties of pigeons. Birds displayed in such shows include the *fantail pigeon,* the *pouter pigeon,* and the *jacobin pigeon.*

Other domestic breeds include the *tumbler pigeon* and the *roller pigeon,* which perform acrobatics displays.

## Pigeons and human beings

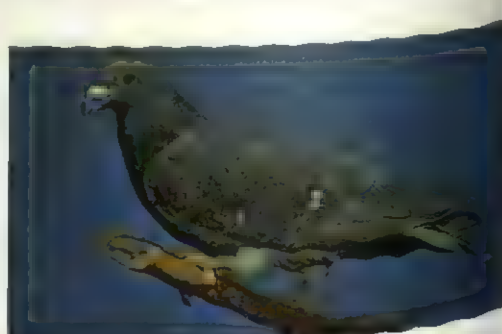
People hunt pigeons for both food and sport. They also use these birds for scientific research. For example, scientists study wood pigeons to better understand bird

**The fantail pigeon** is valued for its beautiful fan-shaped tail. The fantail struts about with its breast puffed out. It is specially bred as a show bird.

**The collared dove** has a narrow, black collar, edged with white, on the back of its neck. The species spread across Europe relying on crops for food and buildings for shelter.

**The bleeding-heart pigeon** gets its name from the red patch on its chest.

**The crowned pigeon** is the largest type of pigeon. It is hunted for its plumage.



**The homing pigeon** is often used for racing and carrying messages. This bird is noted for being able to find its way home from great distances.

behaviour. These birds adapt well to captivity. Scientists also study homing pigeons in an effort to learn how birds are able to find their way when flying great distances.

Some kinds of pigeons, including wood pigeons and collared doves, eat large amounts of crops grown by farmers. But other species eat the seeds of various harmful weeds.

Many large towns and cities have a wide central square or concourse where pigeons gather in large numbers during daylight hours. Some visitors and children enjoy feeding them. But pigeons that live in cities can be a great nuisance to people. The droppings of large numbers of pigeons are expensive to clean up and may help erode stone and marble. The droppings may also stop up the gutters of buildings. In addition, the birds can spread such diseases as histoplasmosis and psittacosis, which can be passed on to human beings (see **Histoplasmosis; Psittacosis**).

**Scientific classification.** Pigeons belong to the order Columbiformes. Pigeons and doves make up the pigeon and dove family, Columbidae. The wood pigeon is classified as *Columba palumbus;* the collared dove is *Streptopelia decaocto;* the rock dove is *Columba livia;* and the mourning dove is *Zenaida macroura.*

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| Mourning dove | Turtledove |

**Pigeon guillemot.** See Guillemot.

**Pigeon hawk.** See Falcon; Falconry.

**Pigeon racing** is a sport that tests the speed at which homing pigeons can reach their home when released a given distance away from it. Homing pigeons are birds that are specially trained to fly back to their owners' roosting boxes, called *lofts.* The pigeons take part in races over graded distances ranging from 100 to 1,600 kilometres.

Pigeon racing is a popular sport in Britain, where the racing season lasts from late April to late September. Local clubs organize races. Any of several pigeon-racing unions provide officials. The officials supervise the events and keep race records.

Every *pigeon fancier* (person who breeds and races pigeons) has a special clock. A union official sets these clocks the night before a race. Another official marks each pigeon in the race by attaching a rubber ring to its leg. The fanciers then take their pigeons in baskets to a prearranged starting point. The race begins with the release of the pigeons from their baskets. The birds then fly home to their lofts. When a pigeon returns, the owner removes its ring. He or she then *strikes* the clock that records the time at which the bird arrived home. The bird with the highest speed home is the winner.

Over 100,000 pigeon fanciers take part in national or local events in Britain, sometimes for large prizes.

**Pigfish.** See Grunt.

**Piggott, Lester** (1935- ), one of Britain's most successful jockeys, was noted for his exceptional timing of race finishes. He was champion jockey in 1960, and in every year from 1964 until 1971. Piggott won most of the classic races. He won the Derby nine times and the St. Leger seven times. He also became the first rider to win the Ascot Gold Cup four times. In 1978, he became the first jockey to win the Prix de l'Arc de Triomphe, Europe's richest race, in two successive years. Piggott was born at Wantage, in Oxfordshire, England. He rode his first winning horse when he was 12. In 1987, Piggott was jailed for evasion of income tax. He was released on parole in 1988, after having spent a year in prison.

**Pigment** is a finely powdered, coloured substance that gives its colour to another material. It does this when it is mixed with the material or applied over its surface in a thin layer. Pigment does not dissolve, but remains suspended in the liquid when it is mixed or ground in a liquid to form paint. Coloured substances that dissolve in liquids and give their colour effects by staining are called dyes. The various methods of painting differ from one another in the material with which the colour is applied. But the pigments used are the same in all types.

See also **Paint; Painting** (Materials and techniques); **Albino; Colour; Hair** (Colour and texture); **Skin.**

**Pigmies.** See Pygmies.

**Pigweed** is a common annual weed. Its strong, hardy root thrives in any cultivable soil. This persistent weed may grow about 60 to 90 centimetres high. It produces large coarse leaves and small greenish flowers that

**Pigeons are released** at the start of a race in which they may fly long distances. The pigeon that is fastest in reaching its loft is the winner.

**The American pika** is a small, furry animal that lives among loose rock on mountainsides. The pika resembles a guinea pig.

grow in a densely crowded head. The leaves are sometimes covered with stiff hairs. Pigweed is best killed by uprooting the plant completely, or by spraying with a weedkiller. The goosefoot is also called pigweed.

**Scientific classification.** Pigweed belongs to the amaranth family, Amaranthaceae. Redroot pigweed is *Amaranthus retroflexus.* Rough pigweed is *A. hybridus.* The goosefoot belongs to the goosefoot family, Chenopodiaceae. It makes up the genus *Chenopodium.*

See also **Amaranth; Lamb's-quarters.**

**Pika** is a small, furry animal that lives in Asia, Europe, and western North America. Pikas belong to the same animal order as hares and rabbits, but they look much more like guinea pigs.

Adult pikas average 18-20 centimetres in length. They have compact bodies, short limbs, rounded ears and stubby tails which are barely visible beneath their dense fur. The fur is greyish-brown on the back, and lighter brown or white on the underside.

Pikas live either high in the mountains or below ground in deserts or *steppes* (grassy plains). They are active during the day, foraging for plant food. In summer and autumn they collect plants to store for winter. They give loud, squeaking calls to warn others of such enemies as eagles and weasels.

**Scientific classification.** Pikas are in the pika family, Ochotonidae. They belong to the genus *Ochotona.* The American species are *O. princeps* and *O. collaris.*

See also **Rabbit.**

**Pike** is the common name of a family of freshwater fish noted for their greedy appetite and fighting quality. Members of the pike family have long, slender bodies and a duck-bill shaped snout filled with many teeth.

**The northern pike** is a large freshwater fish that is popular as a fighting game fish and also as a delicious food fish.

Three members of the pike family are called *pickerel:* the *bulldog pickerel,* also called the *redfin pickerel,* the *mud pickerel,* or the *grass pickerel;* and the *chain pickerel.* The three forms of muskellunge also are in the pike family. The so-called *pike perch,* more accurately called *walleye,* is a perch. The *gar pike* (garfish) is a gar. See **Muskellunge; Pickerel.**

The *northern pike* and the muskellunge are the most important members of the family. They are often displayed as trophy fish. The northern pike lives in the northern fresh waters of Europe and Asia, and in the Great Lakes and smaller lakes in Canada and the upper Mississippi Valley of North America. Large pikes feed on fish, waterfowl, and small mammals. The northern pike may grow to be 1.2 metres long and weigh more than 18 kilograms. It commonly weighs from 1 to 4.5 kilograms. It is bluish- or greenish-grey, with irregular rows of whitish or yellowish spots. It is a fine game fish and its flesh is good to eat.

**Scientific classification.** The northern pike belongs to the pike family, Esocidae. It is *Esox lucius.*

**Pike perch.** See **Perch.**

**Pilate, Pontius,** was a Roman governor of Judea from A.D. 26 to 36, at the time of the Crucifixion of Jesus Christ. Information about Pilate comes from two sources, the New Testament of the Bible and Jewish writers from Pilate's time to about A.D. 100. The New Testament portrays him as generally weak and poor at making decisions, while the Jewish sources depict him as a strong figure of authority. Both sources report that he was unjustly hostile toward the Jews. His name was found in 1961 inscribed on a stone slab near Caesarea in modern Israel.

All four Gospels of the Bible indicate that Jewish authorities manipulated Pilate in their desire to have Jesus crucified. Matthew is the only Gospel to report the famous scene of Pilate's washing his hands, saying: "I am

Detail of *The Maestà* (1308-1311), a tempera altarpiece on wood panel by Duccio di Buoninsegna; Museo dell'Opera Metropolitana, Siena, Italy

**Pilate washed his hands** to symbolize his refusal to accept responsibility for the Crucifixion of Jesus.

The Mayflower in Plymouth Harbor, an 1882 oil painting by William F. Halsall.

The *Mayflower* brought the first Pilgrims from England to what is now Massachusetts, U.S.A., where they founded Plymouth Colony. The ship reached Plymouth Bay, *above,* on Dec. 26, 1620.

innocent of the blood of this just person: see ye to it" (Matt. 27:24). The Gospel of Luke says that Pilate found out that Jesus was from Galilee and sent Him to Herod Antipas, the governor of Galilee, who was staying in Jerusalem at the time. Pilate apparently wanted to avoid having to make a decision about Jesus' fate. At one point in the trial, Pilate offered to release Jesus, probably because he was not convinced of Jesus' guilt.

Some traditions claim that Pilate died in A.D. 39 on the orders of the Roman emperor Caligula, either by committing suicide or by execution. According to another tradition, he and his wife, Procla, became converts to Christianity. Procla is considered a saint in the Greek Orthodox Church, and both she and Pilate are saints in the Ethiopian Orthodox Church.

See also **Jesus Christ** (The trial); **Barabbas.**

**Pilbara** is a region in the northwest of Australia. It extends from Onslow and Port Hedland on the east coast to the Northern Territory border in the west. Iron ore deposits are developed on a large scale in the region, which has some of the richest mineral deposits in the world. Pilbara contains at least 24,000 million metric tons of high-grade ore. Factories have been established that make pellets of iron ore dust. Large quantities of salt are recovered from the sea in the Pilbara region.

See also **Karratha.**

**Pilchard.** See **Sardine; Fishing industry** (table: World-wide fish and shellfish catch).

**Pile** is a column used to support buildings, bridges, and other structures. Piles are often used to prevent buildings from sinking or collapsing. When the top layers of soil are too soft to support the foundation, piles are used to transfer the weight of the structure to a firmer layer of soil or rock. For the foundations of some skyscrapers, piles may descend about 60 metres below the surface. Piles may also be used to raise a structure above water. In addition, piles may serve to support wharves.

Piles may be made of wood, steel, or concrete. They are usually driven into the ground by a *pile driver,* a kind of hammer that drives the pile into position by means of vibration and a weight. Piles also may be drilled into position or placed into predrilled holes.

See also **Breakwater; Building construction** (Foundations); **Cofferdam.**

**Piles.** See **Haemorrhoids.**

**Pilgrim Fathers** were the early English settlers of the New England colony in America. The first group landed at what is now Plymouth in 1620. The Pilgrim Fathers established Plymouth Colony along Cape Cod Bay.

The early Pilgrims included many *Separatists.* These people once belonged to the body of English Protestants known as *Puritans.* The Puritans wished to adopt reforms that would purify the Church of England, the nation's official church. The Separatists decided that they could not reform the church from within. They separated from it and set up their own congregations.

In 1606, William Brewster helped form a small Separatist congregation in Scrooby, England. Separatist groups were illegal in England, and in 1607 the Scrooby congregation tried to flee to Amsterdam, Holland, to avoid arrest. They were caught, but most of them left England the next year. In 1609, the congregation settled in the Dutch town of Leiden.

After several years in Holland, some Separatists began to fear that their children would be more Dutch than English. As foreigners, they could not buy land or work in skilled trades. In addition, war had begun in Europe. The new land of America appealed to them. They offered to establish an English colony in America and found a group of English merchants willing to finance their expedition. In September 1620, 41 members of the

*Pilgrims Going to Church*, oil on canvas, New York Historical Society, New York City

**The Pilgrims walked to church in groups for protection.** Most of the men carried muskets to guard against attacks by Indians. A preacher with his Bible is near the centre of the above picture, painted in 1867 by the American artist George Boughton.

Leiden congregation sailed for America on the ship *Mayflower,* along with 61 other English people. The group reached what is now Provincetown Harbor on Nov. 21, 1620. They explored the nearby coast and soon chose Plymouth as the site of their colony.

The term *Pilgrim* may have come from William Bradford, the second governor of Plymouth Colony. Bradford wrote that "they knew they were pilgrims" when they left Holland. However, for 200 years these people were known as "Founders" or "Forefathers," rather than "Pilgrim Fathers."

See also **Massachusetts; Mayflower; Mayflower Compact.**

**Pilgrimage of Grace** was a rebellion in northern England in 1536. It was a protest against religious changes and against the *dissolution* (breaking up) of the monasteries. It was also influenced by political and economic discontent.

Robert Aske, a lawyer from Yorkshire, led the Pilgrimage of Grace. He captured York and gathered a force of about 30,000 at Doncaster. The Duke of Norfolk, sent to disperse the rebels, came to terms with them, and Henry VIII promised to right their grievances. In 1537, after a further rebellion, Henry broke his promises and seized and executed over 200 of the rebel leaders, including Aske.

**Pilgrimages** are journeys to shrines or other holy places made for religious purposes. People who make such journeys are known as *pilgrims.*

About 100 years after the time of Jesus Christ, Christian pilgrims began making the first pilgrimages to Jerusalem and Rome. In medieval times, pilgrims journeyed not only to the holy sites of Palestine and Rome, but also to the graves of various saints. Special sites of this type include the shrines of Santiago de Compostela (St. James of Compostela), in Spain; of St. Thomas à Becket, in Canterbury, Kent, in southern England; and of St. Patrick, in Downpatrick, Ireland.

A priest would bless a pilgrim as he set out on his pilgrimage. Pilgrims undertook their journeys to enlist the saint's help (for example, in curing an illness), as an act of thanksgiving, as an act of penance on account of a sin, or as a means of expressing religious devotion. Pilgrims would stay at *hospices* or other places where they could take a night's rest. On their return journeys, they wore the emblem of the place they had visited. Pilgrims returning from Jerusalem, for example, wore a palm leaf and were known as *palmers.*

Today, pilgrims continue to visit centres famous in medieval times. But sites identified with modern saints have also become goals for pilgrims. These modern pilgrim sites include the shrines of St. Francis Xavier, in Goa, India; and of Ste. Thérèse de Lisieux, in France. Pilgrimage centres associated with visions of the Virgin Mary include Lourdes, in France; and Knock, in County Mayo, Ireland. Protestants and Roman Catholics both make annual pilgrimages to the chapel of Our Lady of Walsingham, in Norfolk, England.

Muslims who can afford it are expected to make one pilgrimage during their lifetime to the holy city of Mecca (Makkah), in Saudi Arabia. This pilgrimage is known as the *hajj.*

See also **Architecture** (Romanesque architecture); **Islam** (Duties; picture); **Religion** (Religious rituals; picture).

**Pilgrim's Progress.** See **Bunyan, John.**

**Pilgrims' Way** is an old trackway in southern England, running from Winchester, in Hampshire, to Canterbury.

in Kent. It keeps mostly to high ground, following the southern slopes of the North Downs. Parts of the track have been built upon, but it can still be seen in many places. Pilgrims' Way was the route taken by pilgrims travelling from southwestern England to the shrine of St. Thomas à Becket, in Canterbury. The track itself dates from prehistoric times.

**Pillay, Narlana** ( ? - ? ), was Singapore's first successful Indian businessman. He was born into a Hindu family in Penang, in what is now Malaysia. He was working as a clerk when he went to Singapore in June 1819 with Sir Stamford Raffles, the founder of modern Singapore. Pillay set up a brick kiln, and soon had building contracts and a shop dealing in cotton goods. Although all his possessions were destroyed by a fire, he recovered from this bad fortune and, with the help of Raffles, started his business again. Pillay later used his wealth and influence to help other Tamil immigrants. He also built the original Sri Mariamman Temple. Pillay established a Hindu Institute for the education of young Indian boys.

**Pillory** was an instrument once used to punish people for minor offences. It was a wooden framework with holes cut in it for the arms and head of the victims. They were locked into these holes for a certain length of time. The pillory stood in the public square. Prisoners suffered both because of their uncomfortable position and because passers-by jeered and often threw stones and rotten eggs at them. Often the prisoners' heads were shaved to increase their shame.

The English government used the pillory in the 1600's to punish certain writers and publishers. Daniel Defoe was subjected to the pillory for publishing a libellous essay. The Puritans took the pillory with them to America, and used it to punish "notorious drunkards, scolds, and bawds."

See also **Stocks**.

**Pilot.** See **Aeroplane pilot; Ship** (Navigating a ship).

**Pilot, Automatic.** See **Automatic pilot**.

**A pillory** locked the arms and head of a person between two wooden boards. Another device, the *stocks,* held a person's legs. The pillory and stocks were used in England and its American Colonies to punish people who committed minor offences.

**Pilot fish.** See **Pilotfish**.

**Pilot whale** is one of the largest members of the dolphin family. Pilot whales swim in groups called schools. Sometimes hundreds follow one or more *leaders* (pilots). They are found in most oceans, except the polar seas. A pilot whale is black, with a white streak down its underside. The animal may grow 4 to 6 metres long and weigh about 0.5 to 2.5 metric tons. Its head has an organ called a *melon* that is made of fatty tissue. The melon helps the animal locate objects in the water (see **Dolphin** [The bodies of dolphins]). Pilot whales are sometimes called blackfish. The name *blackfish* also refers to various kinds of true fish and to the killer whale (see **Killer whale**).

**Scientific classification.** Pilot whales belong to the dolphin family, Delphinidae. They make up the genus *Globicephala.*

**Pilotfish** is a kind of fish found near the surface in most tropical seas and the warmer temperate seas. It also lives off the coasts of the Americas from Cape Cod

**The pilotfish** is a small sea fish that has five or six dark vertical bands. The fish gets its name because it follows ships and sharks, possibly in search of food.

to Brazil. Most pilotfish are about 30 centimetres long. They are white to bluish-white in colour with five or six dark vertical bands. This fish gets its name because it follows ships, sharks, turtles, and other large moving objects.

**Scientific classification.** The pilotfish is a member of the pompano family, Carangidae. It is *Naucrates ductor.*

**Pilotweed.** See **Compass plant**.

**Pilsen.** See **Plzeň**.

**Piłsudski, Józef** (1867-1935), a Polish patriot, led a movement to liberate Poland from Russia and helped unite his country. Piłsudski served as first chief of state and minister of war in Poland after it became a republic in 1918.

The new democratic constitution provided for a weak presidency, so Piłsudski refused to be a candidate for the office. He quit politics temporarily in 1922, and in 1926 used military force to overthrow the government. Professor Ignacy Mościcki became the new president. Piłsudski became the premier, and served until 1928. In 1930, he became premier again. From 1926 until his death, however, Piłsudski kept the real power of the government in his own hands.

Piłsudski was born near the city of Vilnius, now in Lithuania. He became a professional revolutionary in his youth. He took part in the plot to kill Czar Alexander III

of Russia in 1887, and was exiled to Siberia. After his release in 1892, Pilsudski joined the new Polish Socialist Party and continued to work for the independence of Poland. The Russians again arrested him. Pilsudski was sent to an insane asylum when he feigned insanity, but he escaped from the institution.

During World War I (1914-1918), Pilsudski fought at the head of the Polish Legions he had organized and allied with Germany and Austria-Hungary. But he refused to take an oath of allegiance to Germany, and was imprisoned in the last months of the war.

After the collapse of Germany and Austria-Hungary in the war, Pilsudski became a national hero and headed the Polish provisional government. Later, as chief of state and first marshal of Poland, he led armies against the Lithuanians, Ukrainians, and Russians. During his last years, he increased the presidential powers and limited the power of parliament.

**Piltdown man** was a great hoax in the study of prehistoric people. Between 1908 and 1912, parts of a skull and of a jawbone were found in a gravel pit at Piltdown in Sussex, England. Some scientists believed the remains came from a form of human being who lived 250,000 years ago. Others disagreed. But "Piltdown man" became famous as a "missing link" between physically modern human beings and the apes.

After years of controversy, scientists used newly developed chemical tests on the remains. They learned that the jaw came from a modern ape and that the human skull was much younger than the gravel in which it had been found. In 1955, radiocarbon tests dated the skull at A.D. 1230. Apparently, a prankster had buried an orangutan's jaw and a skull from a medieval cemetery. The jaw had been stained to make it look old and the teeth filed to make them look human.

**Pimento** is the popular name of a small evergreen tree of the myrtle family. A spice known as allspice, Jamaica pepper, or pimento comes from this tree. The red fleshy pimento used to stuff green olives does not come from the pimento tree. That condiment is the fruit of a plant called a capsicum (see **Capsicum**).

The name of the pimento tree comes from *pimienta*, the Spanish word for peppercorns. The tree is native to the West Indies. Most commercial pimento spice comes from Jamaica.

Most pimento trees grow to a height of 6 to 9 metres. However, some pimentos are as tall as 12 metres. The slender, upright trunk of the pimento has many branches at the top and is covered with smooth, grey bark. The shining green leaves are pointed and narrow. They have an essential oil, and have a pleasant odour when fresh. The fruit is a small berry that is black, glossy, sweet, and juicy when ripe, and about the size of a blackcurrant. The unripe berry is used for the commercial spice. The fruit loses much of its pleasant odour when it matures.

**The pimento** bears small berries used to make the spice called *allspice, Jamaica pepper,* or *pimento.*

**Scientific classification.** The pimento is in the myrtle family, Myrtaceae. It is *Pimenta dioica.*

See also **Allspice.**

**Pimpernel** is a small annual plant that grows wild in Europe and Asia. It is sometimes planted in gardens and often runs wild. The plant is low and spreading, with oval leaves in pairs on the stem. The small, bell-shaped flowers grow along the stem. There are several varieties, with red, scarlet, blue, or white flowers. Another name for the pimpernel is *poorman's weatherglass.* This name refers to the flowers' habit of closing at the approach of cloudy or rainy weather.

**Scientific classification.** The pimpernel belongs to the primrose family, Primulaceae. The scarlet pimpernel is classified as *Anagallis arvensis.*

**Pimple** is a red, raised skin blemish that usually contains pus. The most common cause of pimples is *acne,* a skin disorder that frequently occurs among teenagers.

Acne consists of various kinds of blemishes that appear on the face, upper chest, and back. It is caused by hormone changes during the teenage years. One kind of hormone stimulates the oil glands, which then grow larger and produce a lot of oil. The *pores* (openings) of the oil glands at the skin surface are easily plugged, and oil accumulates under the plugs. A plugged pore forms a blemish called a *blackhead* or *whitehead.* Pimples are caused by the *acne bacillus,* a germ that thrives in the accumulated oil. The germ makes irritating substances from the oil, causing redness and pus. Mild acne usually affects only the face and can be treated by washing affected areas regularly and using such nonprescription medicines as benzoyl peroxide. Severe acne should be treated by a doctor. Pimples should not be squeezed. Squeezing may cause scarring.

Other causes of pimples include infections by *staphylococcal* and *streptococcal* bacteria. Unlike acne, in which there are many blemishes, these infections usually start with one pimple. This pimple may develop into a boil. Doctors treat these infections with antibiotics.

Many black men with curly facial hair develop pimples where they shave. These painful "shaving bumps" occur because the coarse, curved whiskers tend to grow into the skin after shaving. Growing a beard relieves this condition.

See also **Acne.**

**Pin** is a short, pointed piece of metal. Pins are used mainly to hold two or more pieces of material together. People also wear pins as jewellery.

There are many kinds of pins. The most common types are *straight pins* and *safety pins.* These pins are usually made of steel or brass. Straight pins have a flat head at one end and a point at the other end. Straight pins are used primarily by seamstresses and tailors to fasten patterns to fabrics and to hold layers together before they are sewn. Safety pins have an oval shape. The point of the pin snaps into a protective guard to prevent the pin from falling out of the fabric and to avoid injuries. Safety pins are used mainly as temporary fasteners.

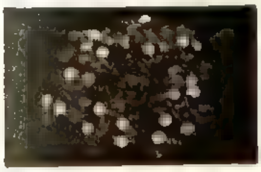
Pins were one of the earliest types of jewellery. Prehistoric people began wearing pins at least 20,000 years ago. Prehistoric people made pins from splinters of bones, wood, and thorns. Later pins were formed out of iron and

Gold and jewelled fibula; Pigorini Museum, Rome

**Etruscan fibula** (500's or 400's B.C.)

Silver brooch with gilding and red enamel; National Museum of Ireland, Dublin

**Irish brooch** (A.D. 800's)



**Man's stickpin** (Late 1800's)

**Brooch** (Mid-1900's)

**Various types of pins** have been produced through the centuries, but their chief uses have remained unchanged. Pins are still used for decoration and to hold pieces of material together.

bronze. The ancient Greeks and Romans used pins called *fibulae,* which resembled modern safety pins, to hold their garments together. Through the years, various types of decorative pins have been developed. For example, large ornamental pins called *brooches* were popular in the 1800's. At that time, women wore them at the centre of the bust, but today they more often use them to adorn their coat lapels. Straight pins known as *stickpins* were originally used in the 1800's and early 1900's to hold men's ties and cravats in place. Today, these pins, which have gems, initials, or emblems of organizations at the top, are worn by some women as accessories on scarfs and lapels.

Pins were handmade until the early 1830's. In 1832, the American inventor John Ireland Howe patented one of the first practical machines for manufacturing pins. In 1849, Walter Hunt, another American inventor, patented a new design that served as the basis for modern safety pins.

See also **Etruscans** (picture: Etruscan jewellery); **Shell** (picture: A butterfly pin).

**Pinang.** See **Penang**.

**Piñata.** See **Christmas** (In Latin America; picture); **Mexico** (Way of life [picture: Blindfolded Mexican children]).

**Pindar** (522?-443 B.C.) was the greatest lyric poet of ancient Greece. He is generally credited with inventing the Pindaric ode. This type of ode is built of three stanzas—the *strophe, antistrophe,* and *epode*—repeated in series. Pindar wrote these stately, intricate poems in praise of some event, such as an athletic victory at the great national games. The games came in four-year cycles, in turn at Olympia, Delphi, Nemea, and Corinth. Pindar's odes were intended for elaborate performance, with music and dance, when the victor returned to his native city. They are unlike other poetry, except for some choral lyrics in the tragedies of the dramatist Aeschylus. They are perfect in form and beautiful in language but lose much of their beauty in translation. Pindar's other poetry was lost.

Pindar was a deeply religious man, the first Greek writer to speak of the immortality of the soul and judgment by the gods after death. In politics, he was conservative and antidemocratic. Pindar's fame was so great that when Alexander the Great burned Thebes to the ground, Pindar's house was the only one spared. Pindar was born at Cynoscephalae, near Thebes, a member of a noble family.

**Pindus Mountains.** See **Greece** (The Central Pindus).

**Pine** is any of a large group of evergreen trees that have needlelike leaves and bear cones. There are about 100 species of pines. Almost all of them grow naturally only in the Northern Hemisphere. Pines are found in a wide range of environments, but they most often grow in sandy or rocky soils. They are especially common in the mountains of western and southeastern North America, southern Europe, and southeastern Asia. Some pines reach heights of about 60 metres. Others are small and shrublike.

Pines belong to a group of plants called *conifers.* All conifers reproduce by means of cones that produce pollen and seeds. A pine differs from other conifers in the way its leaves grow. Nearly all pines have needles that grow in bundles of two, three, or five each. The leaves of other conifers grow in larger bundles or do not form bundles. Conifers closely related to pines include firs, larches, and spruces.

Pine trees bear both male and female cones. The male cones typically measure less than 2.5 centimetres in length. The female cones are much larger and have woody scales. When people speak of "pine cones," they usually are referring to the female cones. In the spring, the male cones produce enormous quantities of pollen. The wind carries the pollen to egg cells attached to the scales of the female cones. The pollen fertilizes the egg cells, which then develop into seeds. The seeds take one or two years to mature. The mature seeds of most pines have winglike parts that cause the seeds to twirl and float in the wind. Pine seeds may blow as far as 90 metres from the parent tree.

Pines rank as the world's most important source of timber. Most pines grow rapidly and form straight, tall trunks that are ideal for timber. Some pines produce *resin,* a substance used to make such products as turpentine, paint, and soap. The wood of many pine species makes excellent pulp for the manufacture of paper. Pines are also grown as shade trees.

### North American pines

About 65 species of pines are native to North America. Two important pines that grow in Canada and the northeastern part of the United States are the *red pine* and the *jack pine.* The red pine gets its name from its reddish-brown bark. It is an important timber tree. The jack pine grows chiefly in sandy soils from the northern Great Lakes region to northwestern Canada.

The *loblolly pine* thrives in many environments throughout the Southeastern United States. An important timber tree, it grows rapidly and is common in abandoned fields and pastures.


**The Scots pine** is one of the few pine species native to northern Europe. This valuable timber tree is also grown in North America.

In the mountains of western North America, different species of pine are found at different elevations. The *Digger pine* grows at lower elevations in the Sierra Nevada and in the Coast Ranges of California.

A number of important pines grow at slightly higher elevations than the digger pine. The *ponderosa pine* is common throughout the Rocky Mountains and the eastern side of the Cascades, and in the Southwestern United States. This pine grows up to 40 metres tall and produces high-quality timber. The *lodgepole pine* grows at higher elevations than the ponderosa pine in the Sierra Nevada and the Rocky Mountains. It thrives in sandy soils and its needles grow in bundles of two.

The *bristlecone pine* is found at extremely high elevations. Some of these trees are among the oldest living things. A number have lived for over 4,000 years. See **Bristlecone pine.**

Several species of pines grow naturally only in small areas of southern California. For example, the *Monterey pine* is native to a small area on the California coast. However, this tree has been introduced into the Southern Hemisphere and now ranks as a major source of timber in Australia, Chile, New Zealand, and South Africa.

### Pines of Europe and Asia

Only a few pine species grow in northern Europe. The *Scots pine,* a valuable timber tree, is probably the most important of these. This is the only European pine to survive the Ice Ages. It is found in mountainous terrain throughout Europe, from Lapland to southern Spain. One of the most beautiful of pines, the Scots pine yields an important softwood which has many applications, especially in the building trade. Large forests of Scots pine remain in Russia and parts of northern Europe.

Many species of pines grow in the countries that border the Mediterranean Sea. Most distinctive perhaps is the *stone pine,* with its large, umbrella-shaped crown. It grows around the northern edge of the Mediterranean, from Portugal to Asia Minor. The stone pine has large, almost round brown cones which contain edible kernels. The *black pine,* also called the *Austrian pine,* is an important source of timber in this region. It also is cultivated worldwide as an ornamental tree. Its close relative is the *Corsican pine.* The Corsican pine is less hardy but grows faster and larger. Native to Corsica, southern Italy, and Sicily, the wood of this species is used for such purposes as pulping. The *Aleppo pine* is the most widespread pine of the Mediterranean region. It grows from Spain and northern Africa near the Strait of Gibraltar to the mountains of Israel and Lebanon.

About 15 pine species grow naturally in southeastern Asia and Japan. Most of them grow in mountainous areas. In northern Asia, the *Siberian pine* ranks as an important pine species. This pine grows from the Ural Mountains through western and central Siberia to northern Mongolia.

The *Bhutan pine* is native to the Himalaya. It is an important timber tree and is also tapped for its resin. It is planted in many countries for its ornamental value.

Specially cultivated forms of the *Japanese white pine* are a common feature of Japanese parks and gardens. These trees, as well as the larger *Japanese black pine,* are grown as *bonsai* (dwarf trees). A commercially valuable species, the Japanese black pine is grown for its timber and resin. In some countries, such as Australia, it is planted along the coast as a windbreak and to stabilize sandy soil.

**Scientific classification.** Pines are in the pine family, Pinaceae. They make up the genus *Pinus.*

**Related articles** in *World Book* include:

Cell (picture: Pine needle cells)
Conifer
Currant
Evergreen
Gymnosperm
Leaf (picture: Vein patterns)
Paper (How paper is made)
Piñon
Plant (Sexual reproduction; diagram: How cone-bearing plants reproduce; pictures)
Resin
Rosin
Seed (picture: How seeds sprout)
Timber (Softwood timber)
Tree
Turpentine

**Pine Gap** is about 25 kilometres southwest of Alice Springs in the Northern Territory of Australia. The Joint Defence Space Research Facility is located there. This facility works on a variety of space research activities. Management of this joint undertaking is shared between the Australian Department of Defence and the United States Advanced Research Projects Agency. The United States and Australian governments share the results of the research activities.

Some 400 people work at Pine Gap. Most of the workers live in the town of Alice Springs. About half of them are Americans. The other half are Australians.

**Pine-tree shilling** was a silver coin minted by American colonists in Boston, in the Massachusetts Bay Colony, from 1667 to 1682. A pine tree encircled by the word *Masathusets* appeared on one side of the coin. The other side bore the Roman numeral *XII* and the date *1652.* The XII stood for twelve pence, which equalled


**The pine-tree shilling** was a silver coin used in the English Colonies in America. It had a pine tree on one side and the date 1652 on the other side.

one shilling. The date 1652 was probably used so that the colonists could claim the coins were minted legally. Under English law, only the monarch was allowed to issue coins. However, King Charles I had been executed in 1649, and Charles II did not succeed him until 1660 (see **England** [History]). Thus, the colonists could claim the coins were minted at a time when royal authority did not exist.

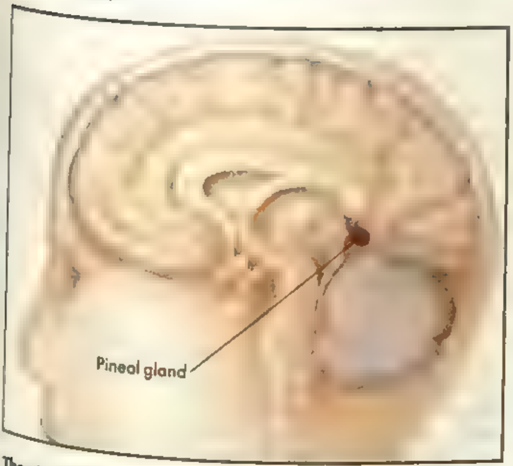
The pine-tree shilling was also called the *Boston shilling* and the *Bay shilling.* Three-penny and six-penny pieces made during the same period bore the same design.

**Pineal gland,** also called *pineal body,* is a tiny organ in the brain of human beings and most other *vertebrates* (animals with a backbone). Scientists are uncertain of the function of the pineal gland in human beings. They believe it plays a role in a variety of important body functions, including certain reproductive processes. In most other vertebrates, the pineal gland helps regulate certain daily and seasonal body cycles.

The pineal gland secretes a hormone called *melatonin.* Its production of melatonin varies with periods of light and darkness in the environment. In most amphibians, birds, fish, and reptiles, the gland is located in the back of the head just beneath the skin. It responds directly to light that penetrates the skin. In mammals, including human beings, the pineal gland lies near the centre of the brain. It obtains information about light in the environment by means of nerve pathways originating in the eyes. In general, light slows and darkness stimulates the pineal gland's production of melatonin. Therefore, the gland tends to secrete small amounts of melatonin during the day and large amounts at night.

In most vertebrates, the pineal gland's secretion of melatonin keeps the animal "timed" to its environment. Most animals live under conditions where the daylength and the temperature of the environment change throughout the year. To survive, they must breed at certain times of the year, usually spring or early summer. The offspring will then have a chance to grow strong enough to survive the first winter. The pineal gland keeps track of the changing daylengths. By means of its melatonin, it sends this information to the body and appropriate reproductive responses are made.

In human beings, melatonin has been linked to the onset of *puberty,* the stage of life when a person matures sexually. Studies have shown that the pineal gland's nightly secretion of melatonin decreases when a boy or girl reaches puberty. Other studies have indicated that melatonin may help regulate menstrual cycles in women and sperm production in men. In addition, researchers have suggested a connection between melatonin levels and certain mental illnesses.




**The pineal gland** is located near the centre of the brain in human beings. It secretes *melatonin,* a hormone believed to play an important role in a person's sexual development.

**Pineapple** is a tropical plant known for its juicy, fragrant fruit. It probably received its name because the fruit looks like a large pine cone. Many people enjoy drinking the juice of the pineapple and eating the fruit as a dessert or in fruit salads. Thailand grows more pineapples than any other country. Farmers there produce about one-fourth of the world's pineapples.

**The pineapple plant** grows from about 60 to 90 centimetres tall, and the fruit weighs from about 2 to 4 kilograms. The ripe fruit has a greenish-orange, yellowish-green, or dark green *shell* (skin). At the top of the fruit is a group of small leaves called the *crown.* The flesh of the fruit, the part eaten by people, is firm and pale yellow, though it may be white. The most widely grown kind of pineapple, *Smooth Cayenne,* is seedless, but some varieties have small brown seeds beneath the shell.

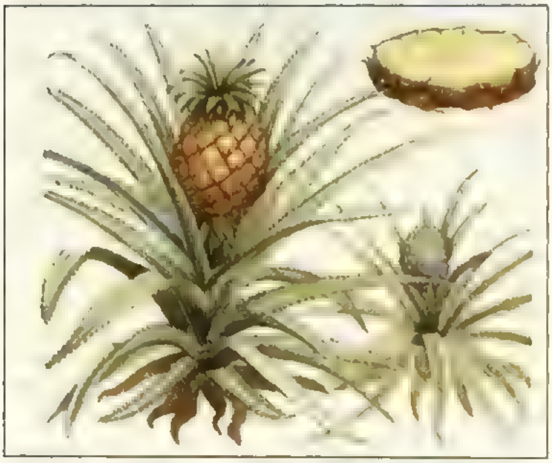
A pineapple plant has blue-green, sword-shaped leaves that grow around a thick stem. The edges of the leaves of most varieties of pineapples have sharp spines. But the leaves of the *Smooth Cayenne* have spines only at the tips and bases. The pineapple plant has underground roots and small roots that grow above ground.

When the plant is from 14 to 16 months old, an *inflorescence* (flower stalk with tiny flowers attached) appears in the centre. The inflorescence resembles a small pink-red cone. After the inflorescence has grown about 5 centimetres high, blue-violet flowers begin to open. Each flower blooms for only one day. All the flowers open within 20 to 30 days. Each flower develops into a fruitlet. The fleshy parts of the fruitlets unite with the stalk to which they were attached. This combination of fruitlets is called a *multiple fruit.* The multiple fruit and the stalk form the yellow centre of the pineapple. The pineapple's shell develops from thick, hard, leaflike structures called *floral bracts.*

**Cultivation and production.** Pineapple plants need

a warm climate and well-drained soil. Too much water can harm them, but irrigation is necessary in some dry regions. Before planting, pineapple growers plough the land deeply and break it up well. In Hawaii, U.S.A., and some other regions, they use a machine to put certain chemicals into the soil to kill harmful roundworms called *nematodes.* The same machine also deposits fertilizer and lays wide strips of plastic on the ground. The plastic strips keep the chemicals from escaping from the soil. The plastic also conserves moisture, keeps the soil warm, and discourages weeds.

Pineapples are grown from any of four parts of a pineapple plant: (1) *shoots,* (2) *slips,* (3) *crowns,* and (4) *suckers.* Shoots grow from the main stem. Slips grow from the flower stalk just below the fruit. Crowns are the groups of leaves at the top of the pineapple. Suckers arise from the roots below ground.



**The pineapple plant** has sword-shaped leaves. Large leaves grow from the stem, and smaller ones grow from the fruit.

**The pineapple fruit** has tangy, juicy flesh. The thick, hard skin may be greenish-orange, yellowish-green, or dark green.

Workers insert the shoots, slips, crowns, or suckers through the plastic strips by hand. They punch holes in the plastic with a planting tool. After planting, pineapple plants require careful cultivation. Growers may use hormonelike chemicals to make the plants flower and produce fruit faster than they would naturally. Machines do most of the weeding, spraying, and fertilizing that used to be done by hand. About 20 months after planting, the pineapples are ready to be picked. A pineapple plant bears one fruit for the first harvest and may bear two fruits for the second or third harvest. Most planters replant fields after every two or three harvests.

In most countries, pineapples are harvested by hand. The pineapple pickers grab the fruit by the crown and twist it from the stalk. They put the pineapples in large baskets strapped to their backs or in big canvas bags carried over the shoulder.

Some pineapple growers use a machine called a *harvester-conveyor* that simplifies the job of picking the fruit. This machine consists of a long *boom* (metal arm) with a *conveyor belt* built into it. The boom is attached to a truck. The truck moves through the pineapple field, with the boom extending over many rows of plants. Pineapple pickers walk behind the boom. They pick the pineapples by hand and drop them onto the conveyor belt. The belt carries the pineapples to the truck.

At the cannery, the pineapples are washed and sorted by size. A machine removes the shells, punches out the cores, and cuts off the ends of the pineapples. Next, the fruit is cut into slices or into pieces of various sizes. Then the fruit is put in cans, syrup is added, and the cans are sealed. The unsweetened juice from the pineapple cores is also canned. Finally, the cans are heated to kill any microorganisms that might cause spoilage.

Pineapple plants also have several other uses. Various parts of the plant are used to make cattle feed, meat tenderizers, and medicines. In the Philippines, people weave the fibres of the plant into a cloth called *piña.*

**History.** Many scientists believe that pineapples originated in Brazil. Christopher Columbus and his crew, who explored the West Indies in 1493, were probably the first Europeans to taste the fruit. Europeans later found pineapples throughout most of South and Central America and the West Indies. They took the fruit to Europe and planted it in hothouses. It became a favourite fruit of royalty and the wealthy.

Commercial production of pineapples began during the mid-1800's in Australia, the Azores, and South Africa. Today, the world's chief pineapple producers include Brazil, China, Indonesia, Ivory Coast, Malaysia, Mexico, the Philippines, South Africa, Thailand, and the United States.

**Scientific classification.** The pineapple belongs to the bromeliad family, Bromeliaceae. It is *Ananas comosus.*

See also **Cuba** (picture: Pineapples); **Fruit.**

**Pinero, Sir Arthur Wing** (1855-1934), ranks second to George Bernard Shaw as the most successful and productive English playwright of the period around 1900. Pinero's work can be divided broadly into two categories: early farces and sentimental comedies such as *The Magistrate* (1885) and *Dandy Dick* (1887); and seri-

ous social plays of his mature years, notably *The Second Mrs. Tanqueray* (1893) and *Mid-Channel* (1909).

Pinero and critics of his day believed his social plays were his most important works. These plays dealt with controversial subjects but usually confirmed, rather than attacked, conventional attitudes and prejudices.

Today, only Pinero's lighter works have retained their appeal. His serious plays now seem to owe their success to the commercial "well-made play" formula that emphasized plot complications over ideas. Pinero was born in London.

**Pines, Isle of.** See Isle of Youth.

**Ping-pong.** See Table tennis.

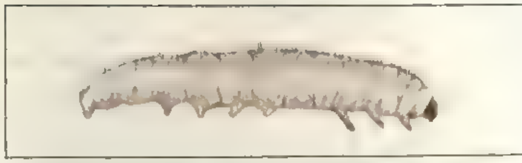
**Pink** is any one of a group of flowering plants that botanists have named *Dianthus,* the Greek word for *Jove's flower.* The blossoms are often seen in shades of pink, but the name *pink,* according to many authorities, is used in the sense of *pierce,* or *puncture,* and refers to the crinkled edges of the petals. The group includes several favourite garden flowers that are admired for their beauty and delicate scent. The spicy fragrance of many old-fashioned gardens comes from clove pinks, clustered in their grasslike leaves, and showing combinations of pink, white, and red. The cultivated pinks include the *carnation;* derivatives of the *common,* or *feather, pink; clove pinks; rainbow pinks;* small-flowered *maiden pinks;* and *sweet Williams,* or *bunch pinks.* Pinks are grown from seeds and cuttings. See also **Baby's breath; Carnation; Sweet William.**

**Scientific classification.** The pink belongs to the carnation family, Caryophyllaceae. The parent of the cultivated carnation is *Dianthus caryophyllus;* the common pink is *D. plumarius;* the rainbow pink, *D. chinensis;* the maiden pink, *D. deltoides;* the sweet William, *D. barbatus.*

**Pink bollworm** is an insect that attacks cotton plants in many parts of the world and can cause crop losses of up to 25 per cent. It is widespread in the Mediterranean, the savannah regions of Africa, the Far East, India, Australia, and Hawaii. The feeding of this insect reduces the yield and quality of cotton lint and the oil content of the seeds. It was first reported in India in the mid-1800's. Experts believe the pink bollworm was imported into the New World from Egypt in shipments of cotton seed.

The adult is a small greyish-brown moth with a wingspread of about 15 millimetres. The larva is about 13 millimetres long. The eggs are laid on all parts of the cotton plant. When the larvae hatch, they feed on the pollen and fleshy parts of the flower. The infested flowers do not open normally, and many fall off. Later, the larvae enter the growing cotton bolls, eat the seeds, burrow through the lint, and check the growth of the bolls. This causes the cotton to rot.

In spring and summer the larvae mature in from 8 to 16 days. Those hatched in autumn and winter may remain as larvae from a few months to two years or more. When the summer larvae are grown, they leave the bolls. They spend the third, or pupal, stage of their lives under rubbish or about 8 centimetres underground. The pupal period lasts from 6 to 20 days. The resting larvae mature in the ground or inside the boll. The insect may be easily carried to any distance while in this resting larval stage. Breeding begins early in spring and continues until frost, with several generations produced in a season.



**The pink bollworm** in the caterpillar stage, *above,* may seriously damage the blossoms and bolls of the cotton plant. The pink bollworm moth, *below,* is the adult form of the insect.

The pink bollworm is a difficult pest to control. It is protected for much of its life, either within the cotton boll or underground. Recent controls have involved attracting male moths and capturing them before they mate. The males are attracted by *pheromones,* the same fragrant chemicals that are emitted by the female moths.

**Scientific classification.** The pink cotton bollworm belongs to the gelechiid moth family, Gelechiidae. It is *Pectinophora gossypiella.*

**Pinkerton, Allan** (1819-1884), an American detective, in 1850 established one of the first detective agencies in the United States. He first won fame for exposing the activities of a band of counterfeiters. In 1861, Pinkerton guarded Abraham Lincoln as he journeyed from Springfield, Illinois, to Washington, D.C., to be inaugurated as president. Soon after the outbreak of the American Civil War (1861-1865), Pinkerton helped organize a federal secret service, of which he became chief. During this time, he operated his own organization in Chicago, and established branches in several cities.

After the American Civil War, Pinkerton organized groups of armed men known as "Pinkerton Men," whose services were available to employers at a daily fee. These forces broke labour strikes that occurred during the Reconstruction period. Members of trade unions hated the "Pinkerton Men" because these men were employed on the side of management against the unions.

Pinkerton also smashed several Western gangs. His earliest "Wild West" case ended with the capture of the Reno brothers, a gang of train robbers, in 1868.

Pinkerton was born in Glasgow, Scotland, and moved to the United States in about 1842. Pinkerton wrote several autobiographical books. His writings included *Criminal Reminiscences and Detective Sketches* (1879), *The Spy of the Rebellion* (1883), and *Thirty Years a Detective* (1884).

**Pinkeye.** See Conjunctivitis.

**Pinkie, Battle of,** took place in 1547 when the Duke of Somerset, Protector of England, led an army into Scotland to try to enforce a marriage between Mary, Queen of Scots, and the young Prince Edward (later Edward VI of England). Somerset won the battle, but lost any chance of establishing a union between the English and Scottish crowns when the Scots sent Mary to the court of France.

**Pinocchio.** See Collodi, Carlo.

**Pinochet Ugarte, Augusto.** See Chile (History).

**Pinochle** is a card game played with a special pack consisting of 48 cards. Each of the four suits has 12 cards, two each of every card from the nines to the aces. The aces are the highest-ranking cards, followed by the tens, kings, queens, jacks, and nines.

There are many variations of pinochle, but one of the most popular forms of the game is *auction pinochle.* It is played by three people, often with a fourth acting as dealer. The object of the game is to bid a certain number and then to reach that score. Players make points in two ways. The winner of the bid *melds*—that is, the bidder lays down certain combinations of cards and adds the points they represent. After the hand has been played, the bidder also receives specified points for the cards in the tricks he or she has taken.

To begin play, the dealer gives 15 cards to each player and sets three, called the *widow,* face down. The player to the dealer's left bids first. The minimum bid is usually set at 300. Every overbid must be a multiple of 10, such as 310, 320, or 330. The player who bids highest turns up the widow for the other players to see and adds those cards to his or her hand. The bidder then names the trump suit and melds. The bidder next discards three cards.

The bidder's opponents play as partners. The bidder picks up the meld cards and leads a card to start the first trick. The other two players each play a card in turn, following suit. A player who cannot follow suit must play a trump card. Each trick of three cards is taken by the person who plays the highest card in the suit led, or who trumps highest. If the two highest cards are alike, the one played first wins the trick.

A winning bidder collects a certain number of points or chips from each opponent. The number, which varies according to local custom, is based on the size of the bid. A losing bidder pays each opponent twice this amount, or just once this amount if the bidder concedes defeat before playing out the hand. When spades are trumps, all points or chips gained and lost are doubled. Partnership auction pinochle, with four players, is another popular form of the game. A simpler form, with no bidding, is a popular two-player game.

**Piñon** is the name of four varieties of small, scrubby pine trees that grow in the semiarid regions of the Southwestern United States. The small cones of the piñon contain seeds, called *pine nuts,* that have a delicate nutty flavour. Pine nuts form an important part of the diet of Indians of the Southwest.

Piñons have short needles that grow singly or in clusters of two, three, or four, depending on the species. The trees often grow as sprawling shrubs, but a few may reach a height of 12 metres. They grow in pure stands or mixed with junipers and scrub oaks. Piñon wood is fine textured and fairly hard. The wood may be used for fence posts, railway sleepers, or fuel.

**Scientific classification.** Piñons belong to the pine family, Pinaceae. They are *Pinus cembroides, P. quadrifolia, P. edulis,* and *P. monophylla.*

See also Conifer.

**Pinscher.** See Doberman pinscher; Miniature pinscher.

**Pint** is a unit of capacity in the British imperial and U.S. customary systems of weights and measures. The pint equals $\frac{1}{2}$ quart or $\frac{1}{8}$ gallon. The *imperial pint* is used in such countries as Australia, Canada, and New Zealand as well as Great Britain. It equals 0.5684 litre and is used to measure both dry and liquid substances. In the U.S. system, one liquid pint equals 0.4732 litre and one dry pint equals 0.5506 litre.

**Pinta.** See Caravel; Columbus, Christopher (First voyage to America).

**Pintado.** See Kingfish.

**Pintail** is a freshwater duck with a long tail. It is found throughout the Northern Hemisphere and ranges over more of the earth than any other kind of waterfowl. In North America, many pintails nest in Alaska and the Yukon Territory. Some fly to eastern Siberia in Asia to nest and then return to North America for the winter.

A pintail has a brown head and neck, with a white line on each side of the neck. The male is grey with a white breast and black tail. Each wing has a patch of shiny green feathers along its edge. The female is brown and has a bronze patch on each wing. Pintails have blue-grey bills. Males have a black line on top of the bill. Pintails are important game birds.

**Scientific classification.** The pintail belongs to the family Anatidae. It is *Anas acuta.*

**Pinter, Harold** (1930- ), is an English playwright. His dramas emphasize a sense of unspoken and sometimes unexplained tensions between the characters.

Pinter's early plays are often called "comedies of menace" because they show ordinary people threatened or attacked by mysterious forces. In *The Birthday Party*

**The pintail** is a Northern Hemisphere freshwater duck. The bird is named after the long, pointed middle feathers of its tail.

(1958), two sinister men hunt down a meek man and punish him for some unspecified offence. In *A Slight Ache* (1959), a silent but menacing derelict frightens a wealthy man into a mental collapse. Other early Pinter plays include *The Room* (1957) and *The Dumb Waiter* (1957).

In the 1960's, Pinter explored the ways in which relationships often break down into power struggles. In *The Caretaker* (1960), two brothers and a tramp form constantly changing alliances against each other. In *The Homecoming* (1965), a son's visit with his wife to his family home leads to a rearrangement of the family power structure. In later plays, Pinter examined how conflicting memories of the past make it impossible to be sure of what really happened. These plays include *Old Times* (1971), *No Man's Land* (1975), and *Betrayal* (1978).

In the 1980's, Pinter turned to political subjects, attacking totalitarian governments in such plays as *One for the Road* (1984) and *Mountain Language* (1988). Pinter has written many screenplays. He is also a stage director and has acted occasionally. Pinter was born in London.

**Pinto.** See **Horse** (Coat and skin; picture).

**Pintubis,** also spelled *Bindubis,* are Aboriginal people who live in the Great Sandy Desert of Western Australia. The desert is largely harsh, arid country of red sand dunes. The Pintubis live in small family groups. They hunt lizards, parrots, and wildcats, and they dig for roots. They are able to live in this harsh environment because they know where water holes are. The Pintubis build light windbreaks for shelter.

**Pinworm,** also called *threadworm,* is a small roundworm. Pinworms are *parasites,* that is, they live in the bodies of other animals. They are about 9 millimetres long and have white bodies and pointed tails. Some pinworms infect horses and rabbits. One kind, *Enterobius vermicularis,* commonly infects humans.

The young worms live in the upper part of the large intestine. When the females are ready to lay eggs, they crawl down the rectum and out of the intestinal opening called the *anus,* usually at night. They lay eggs on the surrounding skin. This movement causes skin swellings and severe itching. The eggs fall off onto the bedding or clothing, or may be picked up under fingernails in scratching. If the eggs are swallowed, they reach the intestine and become adult pinworms.

Pinworms are not very harmful unless they are present in large numbers. Doctors use drugs to treat pinworm infection.

**Scientific classification.** Pinworms belong to the family Oxyuridae, the class Nematoda, and the phylum Aschelminthes.

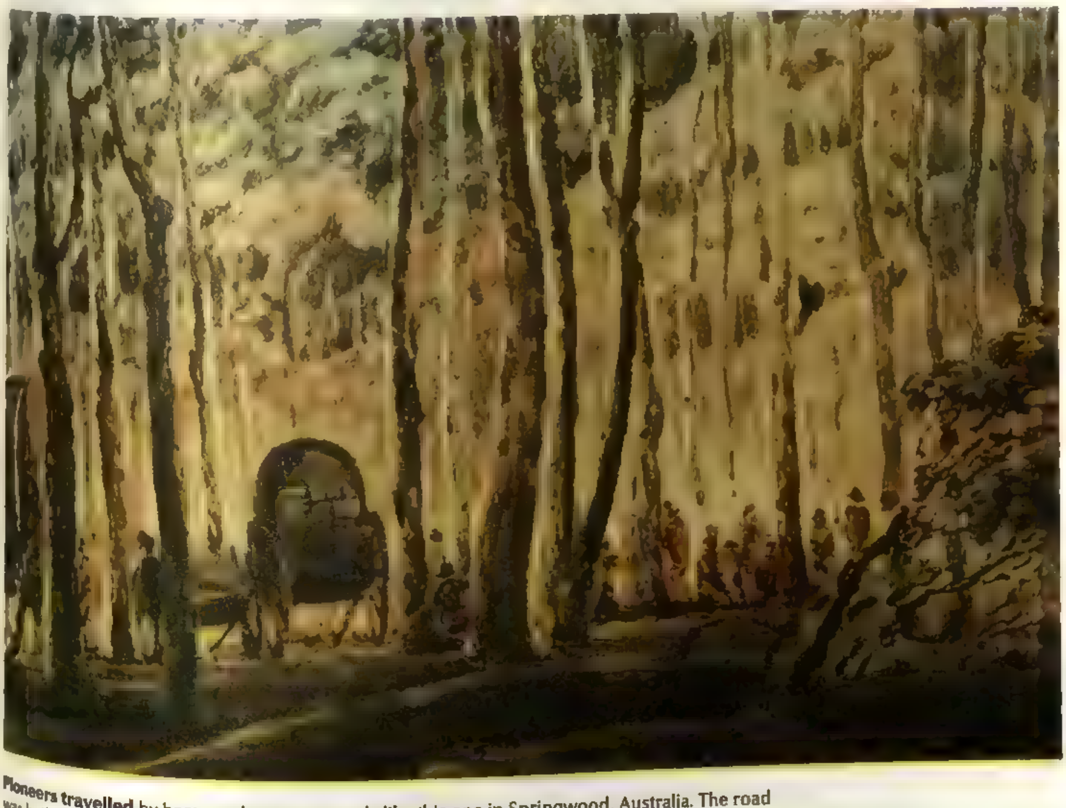
See also **Roundworm.**

**Pinyin.** See China (languages).

**Pion.** See Meson.

**Pioneer,** space probe. See **Space exploration** (Probes to Jupiter and beyond).

**Pioneer life in Australia and New Zealand.** The early pioneers who settled in Australia and New Zealand before 1850 were mainly British farmers. They had been displaced from their small farms by developments in British agriculture. These people belonged to famil-



**Pioneers travelled** by horse and cart over roads like this one in Springwood, Australia. The road was built in 1815, in the Blue Mountains near Sydney.

ies that had farmed the land for hundreds of years. They were easily impressed by promises such as, "Come to a quiet and happy life in a fine climate and a beautiful country where want is unknown."

There seemed to be a lot of truth and hope in what one official said to intending migrants: "Here in Britain you cannot find jobs. You cannot get used to life in the cities. So you cannot be worse off where you are going. At least you will be able to return to your usual way of life on the land."

So the pioneers set out in sailing ships on journeys that took from four to six months. Among the first free settlers in New South Wales, Australia, were a party of five families who arrived in the ship *Bellona* in 1793. They were given selections on an area just outside Sydney known as *Liberty Plains.* In Western Australia, South Australia, and New Zealand, most of the original settlers sailed on voyages organized by Thomas Peel and Edward Gibbon Wakefield. A thousand settlers went first to Norfolk Island, in the southern Pacific Ocean, then on to Hobart, Tasmania. Settlers from Tasmania crossed over into Victoria, on the Australian mainland, in the 1830's. The majority of settlers in Victoria came overland from New South Wales. The first organized civilian settlement in Queensland, northeastern Australia, was in Brisbane in 1842. Those who settled in Brisbane sailed north from Sydney in the ship *Shamrock.*

Large movements of settlers did not begin until after about 1830. For example, in Tasmania, small groups of pioneers landed soon after Governor David Collins founded Hobart in 1804. But free settlers made little progress until 1824, when Governor George Arthur shared out land and allowed more settlers to move away from the Hobart and Launceston districts. In Western Australia, Governor James Stirling landed the first settlers from the ship *Parmelia* at Perth in 1829. But poor conditions kept the settlers in the southwestern corner of the state for many years. Similar problems confined most of the early pioneers of South Australia to the coastal areas. Then, in 1839, a party of 537 Germans arrived from Hamburg to settle in the Barossa Valley. In Queensland, settlers pioneered the Darling Downs in the 1840's.

In New Zealand, about 2,000 missionaries, traders, sealers, and whalers had settled along the coast before 1840. In that year, three ships carrying mostly migrant farmers landed their passengers at Wellington, in the southern part of North Island. In the next few years, set-

**Pioneers from Europe** wore thick clothing that was inappropriate for Australia's hot climate. Men wore flannel shirts and women wore long dresses until about the early 1900's.

**Houses** were made of slabs of wood at first. After 1840, corrugated iron was also used.

**Pioneer women** worked long and hard in rural Australia in the 1800's. This picture shows women gathering mushrooms to add to the family's food supply.

tlements were made in Otago, Wanganui, Nelson, New Plymouth, and Canterbury.

**Housing.** Many of the earliest settlers of Australia and New Zealand brought their first homes with them. These homes were canvas tents. In fact, the first European home built in Australia was a portable framework covered with canvas. It was erected for Governor Arthur Phillip at Sydney Cove in 1788.

The pioneers built various types of homes. Some built houses like the homes they had left in Britain. They made walls of pressed and dried clay or mud, known as *adobe*. They tied rush straw or grass to rafters to make roofs. There was seldom any glass available for windows. The flooring was usually hard-pressed earth. Some flooring was of split logs wedged together with the flat side up. Inside, everybody lived and slept in the same room. Canvas or hessian screens were used for partitions.

The slab hut was the most popular form of housing in early Australia. It remained so in country areas for more than a hundred years. Slab huts were easy to build and could cost no money. The settlers cut slabs for the sides, and often for the roofs, from the bark of trees. They preferred ironbark trees, which had bark that lasted longer and was insect resistant. When the settlers had no steel nails, they used wooden pegs.

At first the richer rural settlers built houses similar to the old British styles. They then learnt to build homes more in keeping with Australian conditions. These homes were low, single-storey buildings with wide verandahs all round. In Australia's climate, people could sleep out on the cool verandahs most of the year.

In areas where good building timber was scarce, many settlers built *wurleys, humpies,* or *shanties.* The wurley was first used by the Australian Aborigines. It was a temporary lean-to shelter, crudely made of bark or branches. The humpy was a small, rough house, rather than just a shelter. It was made from bark, branches, and bits and pieces of any materials available. The shanty was also rough, but usually bigger and better built. Shanties were widely used in outback Queensland. There, and elsewhere, many modern towns and cities have grown up from the old shantytowns.

In New Zealand, many settlers found temporary shelters in Maori huts. These were crude structures built into the ground. Earth was piled around the walls to keep out the cold winds. Shanties and slab huts were also popular.

**Clothing.** Until the discovery of gold in 1851, Australia was a poor country. Most pioneers in the country simply could not afford to buy good clothing. Even when they could afford clothing, it was scarce. So most of the pioneers were poorly clothed.

There was no set style of early Australian clothing. Even when the settlers were able to buy new clothing, they clung to the fashions of their homelands. For example, the Cornish, the Scots, and the Germans all dressed differently. Men wore heavy suits of *worsted* (a coarse woollen fabric) or tweed. They wore heavy bell-top, stovepipe, or bowler hats, or caps and woollen berets. The only early hat that was appropriate for Australian conditions was homemade from the leaves of the cabbage tree. The hat was light, broad-brimmed, and long-lasting. The famous slouch hat worn by outback workers developed much later in the 1800's. Hot flannel shirts took even longer to be replaced by shirts of cooler materials, such as cotton or silk. The old-time bullock drivers, ignoring fashions, fared best, wearing moleskin trousers, red shirts, and cabbage-tree hats. Except for this change, it took more than a hundred years for typical and suitable men's clothing to appear in Australia.

Until 1920, women still wore too much clothing. Their

dresses were generally too long, too hot, and too tight for the Australian climate. For many years, the pioneer women favoured black, principally because the cheapest clothes came in this colour. In winter, they wore tam-o'-shanters or drew their shawls around their heads. Most attractive were the many styles of bonnets, usually worn with ribbons. Pioneer women spun their own woollen thread on spinning wheels. They sewed many garments by hand at home. They washed clothes in copper vats in the open air.

**Food** for the early pioneers was not very nourishing, partly because of difficulties in getting it and partly because people at that time knew little about the health-giving properties of food. People paid high prices for such spices as pepper and nutmeg to add flavour to their tasteless food.

Acting on the advice of James Cook and other explorers, the original settlers in Sydney brought their food with them. It consisted mainly of salted meat and flour. They added fish, kangaroo meat, and possum meat for variety. But, even so, their food rations were close to starvation levels. Several people were hanged for stealing food from the government stores. Food problems eased toward the end of the 1790's as sheep flocks became established.

Unlike other countries, Australia had no native cereal crops, such as maize, rice, or wheat. The first settlers raised vegetables and fruit but had difficulty raising enough wheat to meet their needs. Such local food supplies as could be grown on the generally poor land were often seriously affected by fires, floods, droughts, and pests.

Where possible, many pioneers had their own sheep, cows, pigs, poultry, and vegetable gardens. Most cooking was done outdoors in pots and pans. Indoor cooking stoves did not come into general use until after 1850. The pioneers preserved meat by salting it down into casks or by curing it in smokehouses.

Toward the mid-1800's, transport was available to bring food supplies to most of the outback areas. Then a typical breakfast might consist of porridge, bacon, eggs, and toasted bread. Lunch, if taken at all, might be a soup or stew and *damper* (thin cakes made from flour and water). The evening meal could be a grill, roast, or stew with vegetables, puddings, or cakes. All meals could include tea with sugar and bread with *dripping* (meat fat) or jam.

There were wide variations in diet according to locality because some settlers had fish or fresh fruit available. Many settlers made their own foods such as butter, bread, and jams. Much better local food supplies were available for the New Zealand pioneers because the soil was richer.

**Transport,** until nearly halfway through the 1800's, depended mainly on horses. A fast horse was the fastest means of land transport. Horses also pulled carts, drays, sulkies, wagons, coaches, and other vehicles. Australian settlers preferred bullocks for heavier work on unmade roads and tracks. Bullocks were cheaper to buy and maintain. They also had more stamina when conditions

**The horse** was an important aid in farm work and transport for pioneers in rural Australia.

**Transport** in the 1800's was made difficult by such rugged terrain as the Buffalo Ranges in Victoria, Australia.

were difficult. Where horses would remain bogged in mud, bullocks would pull the wagons through. Bullock teams usually carted the heavy produce.

Australia had no long rivers on which steamships could sail regularly all the year round. The old-time paddle steamers that used to ply on the Murray and Darling rivers were often kept idle by droughts.

Australia's first road, from Sydney to Parramatta, was completed in 1788. The direct distance between Sydney and Parramatta is 24 kilometres, but the actual length of the road was nearly double because it wound around creeks, gullies, and hills. The same obstacles faced all the early road builders. In addition, the builders had poor equipment and little finance. They had to go around obstacles because they could not afford to build roads over or through them. Some money for early roadbuilding was raised by setting up tollgates.

Practically all country roads before 1850 were little more than unmade tracks. Most were slow and difficult to travel on in bad weather. The few existing bridges could easily be washed away by floods. A teamster could move a vehicle across a river by lashing empty casks to its sides and letting it float across to the other side.

Apart from roads to Hawkesbury Valley and Windsor, there was little progress in New South Wales until a 160-kilometre road was made over the Blue Mountains in 1815.

Tasmania's first important road was built in 1818, from Hobart to Launceston. Victoria's first road was built in the early 1840's, from Portland to Mount Gambier in South Australia. In Queensland, the first road was built from Brisbane to the Darling Downs in 1840. In South Australia, some early settlers forced their own ways over the Adelaide Hills to the rich areas beyond. The first two roads were to Port Adelaide in 1840 and to Glen Osmond shortly afterward.

Railways, which did much to open up the outback areas, were built after 1850. Camels, so useful in central Australia, were not used widely until after 1860. Australia's first horse tram opened in Sydney in 1861.

**Occupations** in pioneer Australia were almost all rural before the gold rushes changed the economy of the country. Living conditions were difficult for all the rural settlers, but dairy farmers suffered the most. Their work began before sunrise and usually finished about 16 hours later. For more than 100 years, most dairy farmers lived in poverty. Pioneer Australian wheat growers also led rugged lives, struggling to raise wheat with primitive tools in poor soil. Most produce farmers were too poor to pay for outside labour. For this reason, large families were necessary to help with growing and harvesting the crops. Life improved for wheat growers when John Ridley's labour-saving wheat-stripping machine came into use in the 1840's.

Many occupations in the country were dreary and monotonous. Shepherds had the most taxing routines. In the days before fencing was practical, many of these lonely workers tended their sheep without the help of dogs or horses. The early cattle farmers also lived under extremely rugged conditions, particularly during the annual cattle roundups or when their herds were on the move to market. During these periods, they lived and worked out in the open in all kinds of weather. Often

**Pioneer cottages,** like this one at Mildura, show how Australians lived in the 1800's.

their droving trails extended more than 1,600 kilometres across Australia. Good food and water supplies were usually scarce.

But rural people, even in a poor country, need many services—merchants to buy their produce and sell them goods, doctors, lawyers, ministers, and so on. Australia had all these, and some others whose occupations would be more difficult to list. For example, timber cutters were usually the advance guards for the pioneers. In fact, the first three Europeans known to have lived in Queensland were the timber cutters John Finnigan, Richard Parsons, and Thomas Pamphlett. Sailing north from Sydney, they were wrecked on Moreton Island in 1823. The timber cutters were essentially trailblazers. Many thousands of Australia's modern roads have been built near or on the old timber wagon tracks. In the same way, stonemasons were needed to build some of Australia's most beautiful churches, bridges, and other buildings. These pioneer craftworkers, who were mostly Scots, have left behind many fine historical monuments.

**Law and order.** Up until the 1840's, soldiers were the main guardians of the law in Australia. The laws were made in Britain until each colony received its own legal powers.

In the early days of settlement, the government imposed severe punishments for crimes. A person convicted of petty theft could be hanged or receive a hundred or more lashes with a whip. Some offenders were placed in *stocks,* with their feet held in clamps. Many wrongdoers were forced to walk the *treadmill,* a long set of steps mounted on a moving circular frame. Until 1880, there were public executions in Australia.

People had several methods of dealing with lawbreakers in places where there were no police and courts had not been set up. A meeting of citizens would warn such people to stay out of their district. Some were actually taken out of town on a pole or tarred and feathered. In many cases, citizens would capture and chain a criminal to a tree while they awaited the police. Lynchings were rare.

**Entertainment.** The first stage play in Australia was a comedy called *The Recruiting Officer.* It had a cast of 11 convicts and was performed in Sydney on June 4, 1789.

The first theatre was built in 1796 in Bligh Street, Sydney. In 1803, cricket was first played in Australia in Hyde Park, Sydney. The first horse race meeting was conducted in Sydney in 1805. Stage plays remained the main form of theatrical entertainment until the development of the cinema.

Until 1880, public hangings were considered entertainments and attracted large crowds. But, for the first 100 years of Australia's settlement, organized entertainment was not available for the great majority of country people. Even travelling shows, dance halls, and circuses were scarce until the gold rushes started in 1851.

Early settlers in the outback had to amuse themselves. Their amusements included barn dancing, recitations, sing-songs, picnics, ploughing matches, darts, and card playing. Kangaroo chasing and goat racing were popular. But the strenuous conditions of life left many of these pioneers little time or energy for amusements.

From about 1870, mechanics institutes began to appear in the more settled areas. These institutes were the first community centres to provide amusement and cultural facilities for many people.

**Places of historic interest.** Today, many old homes and places of interest are being preserved. Pioneer villages, built to show how the early settlers lived, are well worth a visit. Such villages exist at Wilberforce and Griffith in New South Wales, at Swan Hill in Victoria, and at Shantytown in the South Island of New Zealand. Original old village settings can be inspected at Richmond, in Tasmania, and at Burra, in South Australia. In Queensland, there are pioneer cottages at Buderim and West Toowoomba. Vaucluse House in Sydney and Como House in Melbourne show the best side of pioneer life. At Parramatta, visitors can see two of Australia's oldest buildings—Experiment Farm and Old Government House. In Western Australia, the Old Mill Museum in Perth is worth a visit. Albany also has much of historic interest. New Zealand's oldest house still stands at Kerikeri. The township of Russell (formerly Kororareka) also has many relics from New Zealand's early history.

**Pipal,** also called *bo tree*. See **Bo tree.**

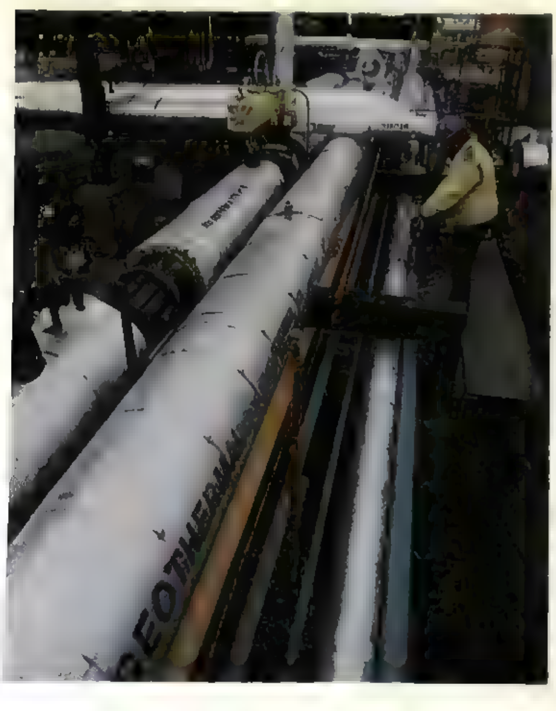
**Pipe** is a musical instrument that is the ancestor of our present pipe organ and all other wind instruments. It is probably the oldest of musical instruments. According to Greek legend, the pipe was invented by Pan (see Pan). Prehistoric people fashioned bones into primitive pipes.

The flute is a pipe of the *whistle* type. In this musical instrument, air blown against a sharp edge sets in motion the air in a hollow tube. The oboe and clarinet are *reed whistles*. In these musical instruments, the movements of a thin piece of wood or other material sets the air in motion. The trumpet operates on the principle of setting the air in motion through vibrations of the player's lips.

See also **Organ; Clarinet; Flute; Trumpet.**

**Pipe** is a tube used to transport liquids and gases from one place to another. Pipelines compare in importance with highways and railways as a means of transporting materials useful to people. Huge pipes bring water to the city from wells, lakes, or other sources of supply. A vast network of pipes then distributes the water to every home, and to each sink, toilet, and other water fixtures in the house. Another network of pipes carries the waste water away from these fixtures through drains and sewer pipes (see **Sewage**). Long pipelines buried in the ground transport and distribute natural gas in some countries in the same way water is distributed (see **Pipeline**). Similar pipelines transport crude oil from wells to refineries.

The walls, floors, and basements of modern office buildings and hotels have a maze of pipes. The pipes carry hot and cold water for general use, hot water or



**Pipes** transport liquids and gases from one place to another. They are made in many different sizes from a variety of materials. The pipes in the picture on the left are part of a large network that transports hot water at a geothermal energy-producing site in Idaho, U.S.A. The pipes shown above are part of a nuclear power reactor that produces electricity.

steam for heating, and refrigerants for air conditioning. Chemical factories, refineries, and similar industries depend almost entirely on pipes to move their products about within the manufacturing plant. Warships often have such a maze of pipes that sailors on the ships find it difficult to move about.

Pipes also serve other purposes than to carry fluids. Pneumatic pipes transport containers carrying messages. Much of our electrical and telephone wiring runs through pipes known as conduits, which protect the wires from water and breakage.

**Kinds of pipe.** Most water pipe larger than 8 centimetres in diameter is made of cast iron, reinforced concrete, steel, or a mixture of asbestos and cement. Smaller water pipes in buildings may be made of galvanized steel, copper, wrought iron, or plastic. Gas and oil pipelines are built of steel pipe. Cast iron, glazed tile, and concrete are among the materials used for drain and sewer pipe. Irrigation systems may have light aluminium pipe that can be easily moved. Atomic-power plants have stainless steel piping. Pipe may be made in several ways, depending on the material and type of pipe desired. These ways include moulding, casting, welding, and drawing or pushing the material over a sharp point to make a centre hole.

**History.** People made pipe of clay thousands of years ago to carry water. The Romans used lead pipe to connect their public fountains to aqueducts. American pioneers made water systems from logs with holes bored through their centres. Later, they made pipes from hoops and wooden staves in much the same way that barrels are made.

**Pipe** is a device used for smoking tobacco. People have smoked tobacco in pipes for more than 2,000 years. Tobacco pipes were brought to Europe during the 1500's by explorers who learned about them from American Indians. The Indians smoked tobacco during religious ceremonies. They also used the pipe as a symbol of peace.

**Pipes come in a variety of shapes and sizes** and are made from such materials as brier, meerschaum, and porcelain.

Pipes consist of two main parts—a bowl and a hollow stem. The bowl holds tobacco, and the stem is connected to the bowl. Smoke from the burning tobacco is drawn into the mouth through the stem. Pipe stems are made of plastic, hard rubber, or bone. The most common materials used for bowls are brier (also spelled *briar*), clay, meerschaum, and porcelain.

Most pipes are named after the type of material used for the bowl. For example, a brier pipe has a bowl made from the hard wood that comes from the root of the brier shrub. This plant grows in such warm, dry countries as Greece, Italy, and Spain. Most brier pipes are produced in standard shapes and sizes, as well as a style known as *freehand*. Freehand pipes have unusual shapes. Brier pipes are made both by machine and by hand.

Meerschaum pipes are made from a white, claylike substance that is found underground in countries near the Mediterranean Sea. Although meerschaum is fragile, it can be carved easily. Meerschaum pipes are crafted into beautiful designs, figures, or scenes. The bowls range in length from about 2.5 to 60 centimetres. Meerschaum changes to a rich brown colour after being smoked for some time.

Porcelain pipes are popular in Europe. Many have hand-painted scenes on the bowls, and cherrywood stems. In the Middle East, the *hookah*, or *water pipe*, is popular. The hookah consists of a bowl connected to a vase of water, and a long flexible stem. Before the smoke enters the smoker's mouth, it passes through the water to cool.

People have been collecting smoking pipes for hundreds of years, and there are pipe collector clubs throughout the world. Members of these clubs meet to buy, sell, and trade old and new pipes.

See also **Brier; Meerschaum; Peace pipe; Smoking; Tobacco.**

**Pipe organ.** See **Organ** (Pipe organs; with pictures).

**Pipefish** gets its name from its long snout, which looks like a tube or pipe. The pipefishes form a group of fish that live in temperate and warm seas. They are relatives of the seahorse, or *hippocampus*. Many pipefish have a long slim body like that of a snake. The body is covered with bony plates. The long snout ends in a small, narrow, toothless mouth. The body is often coloured green or brown to blend in with the seaweeds among which many of them live.

One of the largest pipefish is the *ocean pipefish* of the Atlantic. It is extremely slender, and grows to over 60 centimetres long. The *blue-striped pipefish* of the Indo-Pacific is one of the smallest species, about 6 centimetres long.

Male pipefishes have an unusual pouch on the abdomen in which they carry the eggs. The female fish places the eggs in this pouch, where they hatch. The young pipefish remain in the pouch until they can care for themselves and are able to leave. In the ghost pipefish of the Indo-Pacific, the female carries the eggs in a pouch formed from the pelvic fins.

**The pipefish** has a long slim body covered with bony plates. Its long snout ends in a small, narrow, toothless mouth.

**Scientific classification.** Pipefish belong to the family Syngnathidae. The ocean pipefish is *Enteleurus aequoreus,* the blue-striped pipefish is *Doryrhamphus melanopleura,* and the ghost pipefish is *Solenostomus cyanopterus.*

**Pipeline** is a system of pipes that transports certain substances over long distances. Pipelines play an important role in the operation and the economy of modern communities. They carry most of the water used in homes, businesses, and industry, and transport natural gas, petroleum, and such petroleum products as petrol, paraffin, and diesel fuel. They also carry industrial waste and sewage, and particles of coal, iron ore, and limestone used for industrial purposes.

Many pipelines consist of a series of steel pipes welded together. But many gas and water pipelines are made of such plastics as polyethylene and polyvinyl chloride. Pipelines are also made of aluminium, concrete, iron, or a combination of asbestos and cement. Water pipelines are often built in segments connected at special joints with water-tight gaskets or sealing materials.

A pipeline may be more than 4,800 kilometres long. Pipelines range in diameter from 5 centimetres to 5 metres. Most pipelines are buried about 1 metre underground. Some are laid on the ground or along supports above the ground. Some lines are laid under water. Pipelines run across deserts, over mountains, and under rivers and lakes.

Pipelines are among the most efficient means of transportation. They deliver large quantities of materials in a continuous flow directly from a supplier to a user. A pipeline 1,000 kilometres long and 100 centimetres in

**The Trans-Alaska Pipeline** stretches about 1,300 kilometres and taps the oil reserves of Alaska's North Slope. About half the line runs along supports above ground, *above.*

diameter can transport about a million barrels of petroleum a day. Although pipelines are expensive to build, they are relatively cheap to operate and maintain. They distribute more fuels used as energy—chiefly petroleum, petroleum products, and natural gas—than do any other means of transportation.

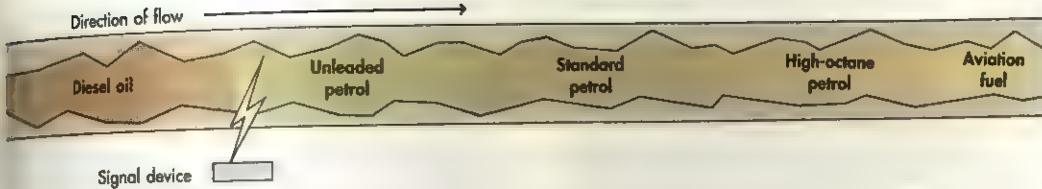
## Kinds of pipelines

There are three chief kinds of pipelines: (1) gas pipelines, (2) liquid pipelines, and (3) solids pipelines.

**Gas pipelines** carry mainly natural gas. Pipes called *gathering lines* transport the gas from the well to processing plants. The processed gas is then fed into *transmission pipelines,* which carry it to cities and towns. There, the gas is delivered to consumers through *distribution lines.* There are two kinds of distribution lines, *mains* and *individual service lines.* Mains are large pipes connected to transmission pipelines. Service lines are smaller pipes that branch out from the mains. They carry the fuel sold by utility companies to homes, offices, factories, and other consumers.

**Liquid pipelines** carry chiefly petroleum, petroleum products, and water. In transporting petroleum, gathering lines take the oil from the well to *trunk pipelines.* Some trunk lines move the oil directly to refineries. Others take it to shipping points for delivery to the refineries by tankers, barges, railway cars, or trucks. The refineries use the petroleum in making petrol, lubricating oil, and other products, which are carried to market areas through *product pipelines.*

Water transmission pipelines bring water to cities and towns from reservoirs, wells, lakes, and other sources. The water then flows into distribution pipelines, through mains, and into service lines that lead to every building in the community. Pipes inside each building distribute the water to the taps, toilets, and other plumbing fixtures. Another network of pipes car-




**A petroleum products pipeline** carries several products at a time by a process called *continuous batching.* Various signal devices, such as computers and *gravitometers,* indicate where one product ends and another begins. A gravitometer distinguishes between products by their weight.

ries waste water and sewage from these fixtures through drains and sewers. Water pipelines also supply water for industrial uses, such as in irrigation systems and mining operations.

**Solids pipelines** transport most materials in the form of *slurries,* which are mixtures of liquids and finely ground solid particles. Slurries include coal and water, iron ore and water, limestone and water, and coal and oil. They flow like liquids, and pipelines that carry slurries resemble liquid pipelines. Solids pipelines transport certain materials, such as sawdust and wheat, by means of air flowing through the system.

### How pipelines work

Pipelines use tremendous pressure to transport the substances being carried through them. This pressure usually ranges from about 3 to 140 atmospheres at the beginning of the pipeline. It moves natural gas about 24 kilometres per hour and liquids and slurries at 3 to 8 kilometres per hour.

As the substance travels through the line, the pressure propelling it decreases because of friction of the material against the walls of the pipe. Therefore, the material requires a boost of energy about every 50 to 250 kilometres to push it along. This energy is supplied by *compressor stations* for gas pipelines and by *pumping stations* for liquid and slurry lines. The flow of material through a pipeline may also be regulated by control valves along the route.

Several materials at a time can be transported by pipelines that carry petroleum products. The different materials are pumped through the line one after the other in "batches" at least 25 to 35 kilometres long. The materials are arranged so that the most valuable substances are separated from the least valuable. This arrangement reduces any damage that may result if some of the products get mixed together. Near the end of the line, an instrument called a *gravitometer* determines the dividing line between products by measuring the differences in their weights.

Pipelines are continually inspected for leaks and for damage caused by such conditions as freezing temperatures, heavy rain, and soil erosion. The locations of underground pipelines are marked to prevent damage from any future construction projects. A coating of tar or some other substance helps protect pipelines against corrosion. Special control devices are installed in pipelines to minimize damage to the environment that may be caused by breaks in the line. In most cases, the land dug up during the construction of a pipeline is reclaimed within three to five years.

Many people believe that pipelines should not be built in certain areas. Environmentalists fought for years to prevent the construction of the Trans-Alaska Pipeline, in the U.S.A., which opened in 1977. They argued that the pipeline and the heat of the oil travelling through it could upset the delicate ecological balance of the frozen land. Some conservationists opposed the construction of slurry pipelines in the Western United States. They believed the limited water resources of the region were too important for agricultural purposes to be used in pipelines.

### Major pipelines of the world

The nations of the Middle East rely heavily on pipelines to transport the region's huge production of oil. For example, the Trans-Arabia Pipeline runs about 1,200 kilometres across Saudi Arabia between the Persian Gulf and the Red Sea. This pipeline eliminates the need to use the shipping lanes through the Strait of Hormuz, between Oman and Iran.

One of the world's longest pipelines, the Export Pipeline, delivers natural gas more than 6,400 kilometres from western Siberia, in Russia, to European countries, including Austria, Belgium, France, Germany, Italy, and the Netherlands. Another pipeline, eastern Europe's Friendship Pipeline, transports oil about 4,000 kilometres from the Ural Mountains, in Russia, to the Czech Republic, Germany, Hungary, and Slovakia. Yet another important pipeline, the South European Pipeline, transports oil nearly 800 kilometres from Lavéra, France, to Karlsruhe, Germany.

In China, the oil fields of Manchuria are linked with Qinhuangdao, a port on the Yellow Sea, by a 1,150-kilometre pipeline.

In Australia, which is the world's driest continent, several pipelines carry water long distances from weirs and rivers to towns and cities that have little water of their own. In Western Australia, for example, a pipeline about 560 kilometres long carries water from the Mundaring Weir, near Perth, to the gold-mining towns of Coolgardie and Kalgoorlie. In South Australia, another pipeline about 360 kilometres long carries water from Morgan, a town on the Murray River, to Whyalla, a town that has an average rainfall of less than 250 millimetres a year.

Pipelines built to carry natural gas are also important in Australia. In Western Australia, for example, a pipeline 1,300 kilometres long carries natural gas from the Northwest Shelf to Perth. In Queensland, another pipeline 350 kilometres long carries natural gas from Roma to Brisbane. In Victoria, a pipeline 174 kilometres long carries natural gas from Bass Strait to Melbourne. In South Australia, a pipeline carries natural gas from the Cooper Basin to Adelaide and Sydney.

In the United States, an extensive network of pipelines crisscrosses the country. One of the longest of these pipelines carries natural gas from Baton Rouge, Louisiana, to Pittsburgh, Pennsylvania, Philadelphia, and New York City. It is about 3,200 kilometres long and has about 13,000 kilometres of branch lines.

The Trans-Alaska Pipeline was built to help reduce a fuel shortage in the United States by tapping Alaska's vast oil reserves. The pipeline runs about 1,300 kilometres from Prudhoe Bay on the Arctic Ocean in the north to Valdez on the southern coast of Alaska.

### History

The first pipelines of historical importance made up part of the water distribution system of ancient Rome. This system was more than 612 kilometres long and may have carried up to 1,200,000,000 litres of water daily. It was constructed so that the force of gravity carried the water through the system. In 1582, the first pumps for pipelines were installed in the water system of London. During the mid-1800's, pipelines started to become an important part of the water distribution system in many industrial countries.

The pipeline industry grew rapidly after the development of seamless, electrically welded pipe in the 1920's. This pipe was much stronger than earlier types. It could carry materials under greater pressures and, thus, in larger quantities. It enabled gas and oil companies to build profitable pipelines over 1,600 kilometres long. Today, such lines make up the networks that carry oil and natural gas from the major producing areas to refineries and distribution points.

See also **Coal** (Shipping coal); **Gas; Irrigation; Petroleum** (Transporting petroleum); **Pipe** (picture: Pipes); **Water** (City water systems).

**Piper, John** (1903-1992), became one of the United Kingdom's leading artists. He used many media, and his works show a distinctive, abstract style. He designed the stained-glass windows for the new Coventry Cathedral in 1962. Some of his topographical paintings were commissioned by Queen Elizabeth II. Many of his paintings show scenes of war destruction. His other works include theatre-set design and books on theatre design and architecture.

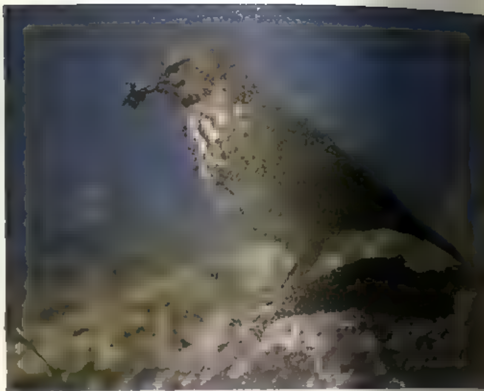
Piper was born at Epsom, in Surrey, England, and educated at Epsom College and the Royal College of Art. He wrote *Brighton Aquatints* (1939) and *Buildings and Prospects* (1949).

**Pipis** are shellfish that live just below the surface of sloping, sandy beaches. They burrow with their extendable tongue-shaped muscle. Their shells are formed from two wedge-shaped valves. Pipis are found in Australia, from southern Queensland to the south coast of Western Australia, and also in New Zealand.

**Scientific classification.** Australian pipis are *Plebidonax deltoides.* New Zealand pipis are *Paphies australe.*

**Pipit** is a small songbird that mainly lives in grassland. Pipits, like their close relatives wagtails, probably originated in open grassland in Africa. Today, they are distributed throughout the world, except for the extreme north and south and some oceanic islands.

Pipits are mostly small, slender birds with long tails and legs. Generally they are brown, heavily streaked, with paler underparts. The outer tail feathers are pale or white. The *golden pipit,* found mainly in the African savanna, is distinctive for its showy yellow underparts.



**The rock pipit** breeds in rugged coastal areas, feeding mainly on shoreline insects and plant foods.

Pipits usually nest on the ground, beneath a clump of vegetation. Some, such as the *rock pipit,* nest in holes in cliffs or river banks. They feed mainly on insects. In some species, such as the *meadow pipit,* the breeding season depends on the availability of food. Several species migrate over long distances.

**Scientific classification.** Pipits belong to the pipit and wagtail family, Motacillidae. The golden pipit is *Tmetothylacus tenellus;* the rock pipit is *Anthus spinoletta;* and the meadow pipit is *A. pratensis.*

**Piraeus** (pop. 179,967) is the third largest city in Greece. Only Athens and Salonika are larger. Piraeus lies along the Saronic Gulf, 8 kilometres southwest of Athens. For location, see Greece (map).

Piraeus has three harbours and is the leading Greek port. Over half the country's imports and exports pass through the harbours. Products of Piraeus include alcoholic beverages, cloth, leather, metal goods, and soap.

Piraeus was an important Greek port in ancient times. In the 400's B.C., the Athenians built walls at its harbours and between Piraeus and Athens to protect Athens from invasions. About 450 B.C., the Greek architect Hippodamus created a city plan for Piraeus based on the regular arrangement of rectangular city blocks. The plan was one of the great achievements of the Age of Pericles (see **Pericles**). In 86 B.C., the Roman general Lucius Cornelius Sulla destroyed the city's harbours. Piraeus then became a small, unimportant village. In A.D. 1834, the Greek government restored the harbours, and Piraeus again grew in size and importance.

**Pirandello, Luigi** (1867-1936), an Italian author, won the 1934 Nobel Prize for literature. Pirandello is known for his philosophic dramas. The best of his plays argue that reality is unknowable, and that truth varies according to the point of view. He claimed we assume numerous roles or masks, none of them our true self.

Pirandello's best-known play is *Six Characters in Search of an Author* (1921), a fantasy that highlights the gap between reality and fiction. *Henry IV* (1922) is a milestone of modern psychological drama that examines the relation between truth and illusion. Pirandello's 1917 play *Right You Are (If You Think You Are)* is a direct analysis of the relativity of truth. In addition to his 44 plays,

Pirandello also published six volumes of poetry and wrote more than 300 short stories. The best of his seven novels is probably *The Late Mattia Pascal* (1904).

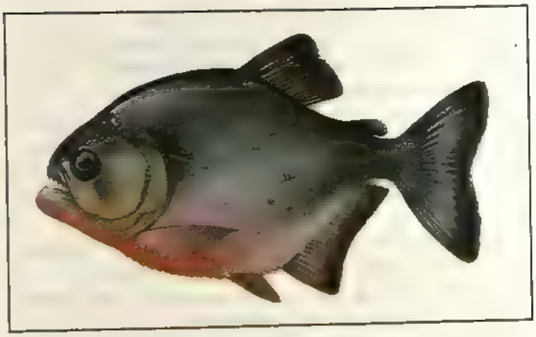
Pirandello was born in Girgenti (Agrigento), Sicily. He earned a doctorate in philology at the University of Bonn in Germany in 1891. He married in 1894 and led a contented life until his wife went insane in 1904. To finance her home care, he taught literature at a girls' school in Rome, enduring his wife's frequent bouts of violent jealousy. His turbulent domestic life helped stimulate the emphasis in his dramas on madness, illusion, and the uncertainty of reality.

See also **Italian literature** (The 1900's).

**Piranesi, Giovanni Battista** (1720-1778), was an Italian printmaker known for his etchings of ancient Roman architecture. His works inspired architects to imitate Roman designs and influenced the neoclassical style in art of the 1700's.

Piranesi's prints of Rome were published in several collections, including more than 200 in *Roman Antiquities* (1756) and 135 in *Views of Rome* (1748-1778). Piranesi often exaggerated the size and grandeur of the ruins in his prints to show his admiration for the Romans. He also used dramatic highlights and dark shadows to create a feeling of mystery, particularly in a series of 16 etchings called *Prisons* (1745, 1760-1761). These pictures show enormous spaces crowded with chains, pulleys, ropes, stone arches, and high staircases. Human figures seem dwarfed and overpowered by the surroundings. Piranesi said he imagined these scenes while he was delirious from a fever. Artists of the romantic period of the early 1800's admired these dreamlike fantasies.

**A Piranesi etching** from his *Prisons* series shows a dreamlike interior of towering arches and high staircases. The series contrasts with his many detailed scenes of Roman architecture.



**The piranha** has razor-sharp teeth that it uses to attack its prey. Piranhas live in South American rivers and lakes.

Piranesi was born in Mogliano, near Venice, Italy. He studied architecture, stage design, drawing, and printmaking as a youth. He went to Rome in 1740, and settled there in 1745.

**Piranha** is a sharp-toothed fish that lives in lakes and rivers throughout most of South America. Piranhas have been described in films and in legends as vicious, bloodthirsty predators that can tear a human being to shreds in seconds. In actuality piranhas rarely have attacked people. However, piranhas can be a serious problem if introduced into other waters, where they will eat large numbers of native fish, amphibians, and other water animals.

There are at least 25 species of piranhas. They have deep bodies that are flattened on the sides. Most piranhas are olive-green to blue-black, with red or orange bellies. The most common species is the *red piranha,* which can grow to nearly 30 centimetres long. All piranhas have razor-sharp teeth that they use to devour a variety of prey.

Normally, piranhas swim alone and feed on smaller fish or on seeds or fruit in the water. Occasionally, they swim together in shoals. A shoal of piranhas, like a pack of wild dogs, may attack a much larger animal and efficiently bite away pieces of its flesh.

Some fishing enthusiasts value piranhas because the fish are fierce fighters when hooked and are good to eat. Also, some tropical aquarium owners at first enjoy keeping a piranha but later tire of the expense of feeding it. As a result, wild piranhas have been introduced into some rivers and lakes in the United States, particularly in the Southeast.

**Scientific classification.** Piranhas belong to the family Characidae. The red piranha is *Rooseveltiella nattereri.*

**Pirate** is a person who attacks and robs ships. Such robbers have also been called *buccaneers, corsairs, filibusters, freebooters, ladrones, pickaroons,* and *sea rovers.* Pirates differ from sea raiders known as *privateers.* Pirates were not licensed by any nation, but privateers were licensed by a particular nation during wartime to attack enemy ships. Therefore, privateers were generally not considered pirates.

Pirates have robbed ships and raided coastal towns since ancient times. The greatest period of pirate attacks, or *piracy,* occurred from the 1500's to the 1700's

on the Mediterranean and Caribbean seas. The most famous pirates of this age included Henry Morgan, Blackbeard, and William Kidd. Most pirates were men, but a few women became pirates.

Widespread piracy no longer exists. But occasional attacks still occur in some areas, including the South China Sea and the Gulf of Thailand. The word *pirate* comes from the Greek word *peiran,* which means *to attack.*

**How pirates lived.** People became pirates for various reasons. Sometimes, the harsh conditions of life at sea led honest seamen to desert or *mutiny* (seize control of) their ships. These men often turned to piracy to survive. Other men who became pirates sought riches or adventure. Many privateers drifted into piracy when wars between nations ended.

Legend, fiction, and films have helped create an exciting, romantic image of pirates. A typical pirate is portrayed as a fierce-looking man with a beard. He is sometimes handsomely dressed in high black boots, breeches, and an elegant vest. He carries pistols, daggers, and a long sword in his belt.

In real life, however, most pirates probably led miserable lives. They were often drunk and quarrelsome. Many pirates died of wounds or disease. Some were shot or marooned by their own crews or captured and sentenced to death by authorities.

In spite of their unlawful way of life, most pirate crews developed rules and regulations to govern their ships. Crew members elected a captain and other officers and had a code of punishment for breaking agreements. They also developed pay scales to determine each person's share of the *booty* (stolen goods).

Until about 1700, pirate ships flew a red banner called the *Bloody Flag.* They then began using flags that pictured such objects as skeletons, flaming swords, and hourglasses. The most popular of the new pirate flags showed a white skull and crossbones on a black background. This pirate symbol became known as the *Jolly Roger.*

Ships involved in trade carried weapons in case of attack. But a pirate crew usually outnumbered the other crew and could defeat it in hand-to-hand combat after coming aboard. Pirates seized trading ships by first manoeuvring their vessel next to the ship. They boarded by using hooks and ropes to keep the ships together. Ships carrying valuable cargoes often travelled in groups for protection. But storms frequently scattered them.

Besides robbing ships, pirates also attacked towns. In the towns, they murdered innocent people and took prisoners. The pirates held some of the captives for ransom and enslaved others. They sometimes tortured their prisoners to get information about treasure. There is little evidence that pirates made their victims "walk the plank."

**Pirates of the Mediterranean.** Much of the piracy during ancient times occurred along the eastern coast of the Mediterranean Sea. The Roman Empire was threatened by pirates who cut off food supplies and other imports to Rome. In 67 B.C., Roman forces led by Pompey the Great began a campaign that rid the area of pirates for several years.

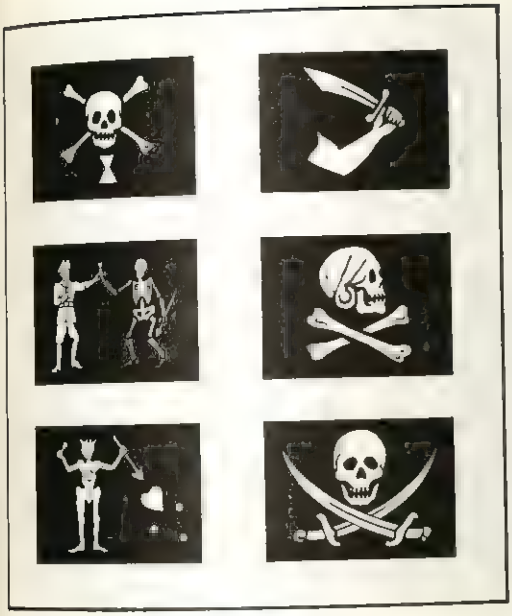
Piracy flourished on the Mediterranean again from the early 1500's to the early 1800's. It resulted partly from a rivalry between Muslims and Christians. Muslim pirates from the Barbary States, which lay along the coast of northern Africa, roamed the Mediterranean and attacked ships of France, Italy, Spain, and other Christian nations of Europe. These pirates, known as the *Barbary corsairs,* had bases in Algiers, Tunis, and Tripoli. The corsairs also raided coastal towns of western Europe. Piracy on the Mediterranean continued until French forces seized the pirate base in Algiers in 1830.

The most famous Barbary corsair leaders were Occhiali, the brothers Arouj and Khair-ed-Din Barbarossa, and Dragut. Other noted pirates of the Mediterranean Sea included Ali Pasha and a woman, Jeanne de Belleville.

**Pirates of the Caribbean and other areas.** During the 1500's, competition between Spain and other European countries to colonize the newly discovered Americas led to an outbreak of piracy on the Caribbean Sea. Pirates sailed the Caribbean for over 300 years. By 1550, Spain controlled the West Indies and large areas of the South American mainland. As a result, bands of English, Dutch, and French pirates robbed Spain's ships and looted its settlements in the Americas. Among these robbers were the "sea dogs" sent by Queen Elizabeth I of England to raid Spanish fleets. They included such famous English sea captains as Sir Francis Drake and Sir John Hawkins. These raiders committed acts of piracy before the queen declared war on Spain and made them privateers.

During the early 1600's, French, English, Dutch, and other European sailors settled on Hispaniola, Tortuga Island, and other Caribbean islands. They raided Spanish ships and towns and soon became known as *buccaneers.* Their numbers grew, and eventually no town was


**A pirate** carried several kinds of weapons, including a pistol, daggers, an axe, and a short, curved sword called a *cutlass.* Most pirates were men.



**Pirate flags** commonly featured a skull and crossbones. Some also pictured a skeleton, a sword, or an hourglass. The flags on the left are associated with, *top to bottom,* Emanuel Wynne, Bartholomew Roberts, and Edward Low. The flags on the right have not been identified with a particular pirate.

safe along the *Spanish Main,* an area along the coasts of what are now Colombia and Venezuela. The most famous buccaneer was the Englishman Henry Morgan. In 1671, he led 2,000 other buccaneers in the looting and destruction of Panama City, Panama, the largest Spanish city in Central America. When it suited them, some buccaneers also served as privateers.

During the late 1600's, the buccaneers sought new targets. Some of them carried out raids in Spanish-controlled areas of the Pacific Ocean. About 1690, the buccaneers and other European pirates began attacking the ships of any nation. Some of the pirates sailed to waters near the slave-trading stations of west Africa. Reports of great wealth lured others to the Indian Ocean. Once there, they ambushed ships that carried rich cargoes of silks, spices, jewels, and ivory. Many of these pirates settled among the people of Madagascar, an island that lies east of the African mainland. Perhaps the best known of the pirates associated with Madagascar was the Scotsman William Kidd. Kidd had been sent by England to capture pirates, but he made friends with them instead and became a pirate himself.

European pirates also turned their attention to North America. By 1700, English colonists had established successful trade routes between North America and Europe. A number of pirates set up a base in the Bahamas and attacked many of the ships that followed these routes. The pirates' leaders included Benjamin Hornigold, "Calico Jack" Rackham, and Charles Vane. Pirates who sailed with these men included the women Anne Bonny and Mary Read. But the most notorious pirate of this time was Edward Teach, also known as Blackbeard. Blackbeard terrorized the Carolina and Virginia coasts in 1717 and 1718. A small fleet of ships from Virginia hunted Blackbeard down and killed him in 1718. By the late 1720's, the British Royal Navy had put an end to most of the activities of European pirates throughout the world.

**Asian pirates.** Beginning in the early 1600's, pirates from countries in Asia attacked European and other trading ships in many Asian waters. For example, Arab pirates operated off India's Malabar Coast, and Malaysian pirates attacked ships in the South China Sea. Pirates from Taiwan and the mainland of China sailed in the waters off China and Japan. By the mid-1800's, however, the navies of Great Britain and of other countries had cleared the seas of almost all pirates, including those from Asia.

**Related articles** in *World Book* include:

| | | |
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| Barbarossa | Drake, Sir Francis | Laffite, Jean |
| Barbary States | Greaves, Captain | Morgan, Sir Henry |
| Blackbeard | Kidd, William | Privateer |
| Bonnet, Stede | | |

**Pirenne, Henri** (1862-1935), was a Belgian historian. He is best known for his seven-volume *History of Belgium* (1900-1932), considered the standard work on the subject. Pirenne specialized in studying medieval economic history, and especially medieval cities. Pirenne's works are noted for their scholarship and bold interpretations, often challenging traditional views. His *Medieval Cities* (1925) and *Mohammed and Charlemagne* (published in 1937, after his death) became classics of historical interpretation, and are still widely read. Pirenne theorized in *Mohammed and Charlemagne* that the Muslim conquests, rather than Germanic invasions, ended the Roman Empire and the ancient world. However, many scholars dispute his theory today.

Pirenne was born in Verviers, Belgium. He was a professor of history at the University of Ghent from 1886 to 1930. While imprisoned by the Germans during World War I, Pirenne wrote a *History of Europe* without using books or notes.

**Pirie, Gordon** (1931- ), was one of Britain's outstanding athletes during the 1950's. He broke many running records, including four world records, but ran disappointingly in all the important international championships in which he competed. He broke the world 6 miles (9,656 metres) record in 1953 and, in 1956, the 3,000 metres record twice and the 5,000 metres record. He was fourth in the Olympic Games 5,000 metres in 1952 and second in 1956. Pirie became a professional athlete in 1961. He was born at Leeds, in West Yorkshire, England.

**Pirogue** is a special kind of dugout canoe, used for fishing in the Gulf of Mexico. The Louisiana pirogue is a flat-bottomed boat made from a cypress log. People use these boats for fishing and transportation in the swamps and bayous of southern Louisiana, U.S.A. The boats range in size from about 1.8 to 6 metres long. They have round, flaring sides and a sharp bow. Either paddles or poles are used to propel pirogues.

**Pisa** (pop. 104,334) is an old city of Italy famed for its marble bell tower (see **Leaning Tower of Pisa**). It lies on both banks of the River Arno. For location, see **Italy** (political map). Pisa has a university founded in 1343 and an academy of fine arts established by Napoleon. The town has valuable art treasures. It is also a manufacturing cen-

tre. The house where the scientist Galileo was born is in Pisa.

**Pisa, Council of,** met in 1409 in Pisa, Italy, to resolve the *Great Schism,* a split within the Western Christian church. The schism began in 1378 when two popes were elected after the death of Pope Gregory XI. Each claimed the allegiance of the church. The Council of Pisa deposed both popes and elected Alexander V pope. The two popes refused to give up their claims, however, and three popes now claimed to head the church. In 1417, the Council of Constance, meeting in Konstanz, Germany, elected Martin V as the new pope. The council deposed two of the earlier popes and the third resigned. Martin's election formally ended the schism. See also **Pope** (The troubles of the papacy); **Roman Catholic Church** (The Great Schism).

**Pisa, Leaning Tower of.** See **Leaning Tower of Pisa.**

**Pisano, Giovanni** (1248?-1314?), was an Italian sculptor and architect. His father, Nicola Pisano, was also a sculptor. Together, they combined the styles of French Gothic art and classical Roman art in works that influenced artists of the Italian Renaissance.

Giovanni's masterpiece is a hexagonal pulpit (1301) in the Church of Sant' Andrea at Pistoia. The pulpit is decorated with five panels that portray episodes related to the life of Jesus Christ. The panels show the Gothic influence in their dramatic composition and in the emotional character of the action.

Giovanni was probably born in Pisa. He began his career in about 1265, working with his father on a pulpit in the Cathedral of Siena. Many art historians believe that Giovanni later designed the cathedral's front, which combines Gothic elements with the earlier Romanesque style.

See also **Sculpture** (Italian Renaissance; picture).

**Pisano, Nicola** (1210?-1278?), was an Italian sculptor, as was his son, Giovanni. Nicola Pisano's reliefs, particularly on pulpits, were created in the classical style that anticipates the art of the Renaissance.

Pisano was probably born in southern Italy, and later moved to Pisa. His masterpiece is the six-sided pulpit (1260) in the Baptistery of Pisa. He carved scenes of quiet dignity for the panels, using forms and details borrowed from Roman monuments. In 1268, Pisano finished a large, eight-sided pulpit for the Cathedral of Siena. In this work, Pisano created more dramatic, unified, and action-filled scenes than in his earlier sculptures.

See also **Pisano, Giovanni; Relief.**

**Pisces** is a group of stars that forms the twelfth sign of the zodiac. This illustration is from *Uranographia* by Johann E. Bode, published in 1801.

**Pisces,** *the Fishes,* is a *constellation* (group of stars) in the Northern Hemisphere, the twelfth sign of the zodiac. Pisces is symbolized by two fish with their tails tied together by a cord. The connecting knot is marked by the star alpha Piscium. This star is known as Al Rischa, which in Arabic means the cord. According to legend, Venus and her son Cupid turned into fish to escape the monster Typhon. Pisces is an unimpressive constellation, consisting of a chain of rather faint stars. The sun passes through the constellation from mid-March to mid-April.

**Pisgah, Mount.** See **Mount Pisgah.**

**Pisistratus** ( ? -527 B.C.) was a popular ruler of ancient Athens. He employed the poor in such public works programmes as building temples and fountains. Later Athenians called Pisistratus' reign "an age of gold," because of his mild rule. Pisistratus gained power in 560 B.C., but the Alcmeonid family took control of the city in 556 B.C. Pisistratus went to nearby Macedonia, made a fortune in mining, and formed an army of hired soldiers. His troops took Athens in 546 B.C., and he ruled until his death. Pisistratus encouraged writers and artists. He ordered one of the first collections of Homer's poems to be made. See also **Library** (Libraries of papyrus).

**Pissarro, Camille** (1830-1903), was a French Impressionist painter. He was the oldest artist of the impressionist movement. Pissarro was also probably the most popular and respected member among the other impressionists. He influenced the careers of such artists as Paul Cézanne, Paul Gauguin, and Vincent van Gogh. See **Impressionism.**

Pissarro had a modest disposition, which is reflected in his fondness for painting humble rural scenes and landscapes. His short, patchy brushstrokes give vitality to these commonplace scenes. Pissarro's early paintings emphasize dark tones. He gradually began concentrating on lighter colours, especially after he started to paint outdoors in the late 1860's. His works show greater concern with structure and design than those of most other impressionists. Pissarro was born on the island of St. Thomas in the Virgin Islands.

**Pissis.** See **Andes Mountains.**

**Pistachio nut,** sometimes called a *green almond,* is the small seed of the pistachio tree. This tree grows in the eastern Mediterranean region, in southwestern Asia, and in the Southwestern United States. Growers in California produce millions of kilograms of pistachio nuts each year. A pistachio nut may be 2.5 centimetres long. It has a smooth, thin, and hard shell that tends to open at the edge. Its thin, smooth husk, or skin, is pale red to yellow. The husk is removed before the kernel is processed. The kernel may be eaten as a nut or ground and used as a food flavouring and colouring. The kernel's texture is very fine. Pistachio kernels can be salted while in the shell by placing them in a salty solution. In southwestern Asia and the eastern Mediterranean region, the kernels are pressed for their oil.

Oil painting on canvas (1870); the Louvre, Paris

**Pissarro's paintings** typically portray quiet rural scenes. His *Carriage at Louveciennes* shows the short, patchy brushstrokes he used to paint these subjects. The placement of the figures, house, road, and trees shows how Pissarro carefully organized his compositions.

The pistachio tree grows well in dry regions. It seldom rises over 9 metres high, but its branches spread widely. Its leaves, which produce a sticky resin, drop off during the winter.

Every pistachio tree is either male or female. In order to produce nuts, the female trees must have a male tree nearby to provide pollen for their flowers.

**Scientific classification.** The common pistachio tree is in the cashew family, Anacardiaceae. It is *Pistacia vera.*

**Pistil.** See **Flower** (The parts of a flower).

**Pistol.** See **Handgun.**

**Pit bull** is a name commonly applied to any of several breeds or crossbreeds of dogs usually having some mixture of bulldog and terrier. Pit bulls were once used for attacking bulls and bears. These dogs have occasionally attacked, and even killed, people. Breeds sometimes called pit bull include the *American pit bull terrier,* and the *American Staffordshire terrier.* Some people also classify as pit bulls other breeds, such as the *bull terrier, bulldog, bullmastiff,* and *Staffordshire bull terrier.*

Because of their fearless, aggressive, and tenacious nature, pit bulls have been used in organized dog fights. Such dog fights are illegal in many countries.

During the 1980's and 1990's, public and press attention became focused upon pit bulls because of their use in fighting and because of much-publicized attacks on people. In 1991, the United Kingdom government introduced legislation requiring that dangerous dogs, including American pit bull terriers, be kept on a lead and muzzled in public. The law also made it illegal for them to be bred. In the United States and Canada, some communities have passed laws prohibiting or limiting the ownership of pit bulls and other dangerous dogs, or compelling owners to take out liability insurance.

Pit bull attacks on people have been blamed on the natural aggression of the dogs. Pit bulls are not the only dangerous dogs involved in attacks on people, and many experts have stressed the difficulty of identifying a dog as a pit bull. Some experts consider that the fault also lies with irresponsible owners, who may have abused their dogs or brought them up to attack.

**Pit viper.** See **Viper.**

**Pitcairn Island** is a small, isolated island in the South Pacific Ocean. It lies just south of the Tropic of Capricorn, about 8,000 kilometres east of Australia. For location, see **Pacific Islands** (map). Pitcairn is famous as the home of the mutineers of the British naval ship *Bounty.*

Pitcairn covers only about 5 square kilometres. The island rises sharply from the sea to an elevation of about 250 metres. The interior is rugged, but it has fertile soil. The climate is mild. Average temperatures range from about 24° C in February to about 19° C in August. Rainfall averages 200 centimetres yearly.

**Pistachio nuts** grow in clusters on pistachio trees. The edible green kernel, *right,* has a mild flavour.

Pitcairn is the main island of a British dependency called the Pitcairn Islands Group. The other islands, all uninhabited, are Ducie, Henderson, and Oeno. The British high commissioner to New Zealand heads the dependency's government. A council composed of Pitcairn residents directs local affairs.

About 60 people live on Pitcairn. Most of them are descendants of the *Bounty* mutineers and their Polynesian wives. Adamstown is the island's only settlement. Most of the people farm and fish for a living. The main crops are bananas, citrus fruits, coconuts, pumpkins, taro, watermelons, and yams. The government gets much of its revenue by selling postage stamps that bear the words "Pitcairn Islands" to collectors.

Pitcairn was inhabited in prehistoric times, probably by Polynesians. However, no one was living there in 1767, when the English navigator Philip Carteret and his crew became the first Europeans to reach it. Carteret named the island after Robert Pitcairn, the crew member who first sighted the island.

In 1789, mutineers led by Fletcher Christian took control of the *Bounty* from Captain William Bligh in the South Pacific. Bligh and 18 nonmutineers were cast adrift in a small boat. In 1790, nine of the mutineers settled on Pitcairn. These British sailors brought 19 Polynesians with them—6 men, 12 women, and a young girl.

By 1808, when an American ship discovered the mutineers' hideout, all the men except the mutineer John Adams were dead. But the mutineers had left 25 children. In 1856, many of Pitcairn's people moved to Norfolk Island (see **Norfolk Island**).

See also **Bligh, William; Nordhoff and Hall.**

**Pitch.** See **Propeller; Screw.**

**Pitch** is a black, gluelike substance that is left behind when coal tar or petroleum is distilled. In its natural form, it is called *asphalt.* Pitch is highly adhesive and water repellent. It is used for roofing materials, road pavings, and waterproofing applications. Pitch is also used in making the carbon *electrodes* (electrical poles) for the electrolytic cells that produce aluminium.

See also **Asphalt; Coal tar.**

**Pitch** is the characteristic of a sound determined by the *frequency of vibration* of the sound waves. High-pitched sounds have higher frequencies than low-pitched sounds. When violin players tune their instruments, they adjust each string so that it will vibrate at the desired frequency (see **Sound**).

The pitch of most sounds we hear is actually due to a blend of various frequencies. The sounds produced by a musical instrument, a whistle, or a siren have several frequencies at the same time. The lowest frequency, called the *fundamental frequency,* is produced by an object vibrating as a whole. The higher frequencies, called *harmonics* or *overtones,* are produced by an object vibrating in parts. For example, a violin string vibrates as a whole, and in halves, thirds, and so on at the same time. The overtones are whole number multiples of the fundamental frequency. A tuning fork produces a sound wave of a single frequency. So do pitch pipes, which are used to get the correct number of vibrations for certain notes. Physicists distinguish between pitch and frequency. They use the term *pitch* to refer to the psychological judgment of frequency, which depends on the loudness of the tone.

The notes we play and sing today did not always have the same pitch. Composer George Frideric Handel tuned the A above middle C as low as 422.5 vibrations a second. Today, the standard for pitch is the Stuttgart, or concert, pitch, adopted in 1939. It places A at 440 vibrations a second.

See also **Music** (Tone); **Harmonics; Vibration.**

**Pitch and putt.** See **Golf.**

**Pitchblende** is a variety of uraninite, a mineral that consists chiefly of uranium and oxygen. The ore is highly radioactive. In 1898, the French physicists Marie and Pierre Curie obtained radium, a rare element used in medicine and the physical sciences, from pitchblende. Pitchblende ranks as the chief mineral source of uranium, which is used to produce nuclear energy.

The word *pitchblende* comes from *pitch,* a shiny substance made from tar. Pitchblende has a tarlike lustre and ranges in colour from black to dark brown. Countries where pitchblende is found include Australia, Canada, the United Kingdom, and the United States.

**Pitcher plant** is the name of some green plants that have pitcher-shaped leaves that form traps for insects. Pitcher plants are *insectivorous plants,* that is they feed on animal life (see **Insectivorous plant**). Like other green plants, pitcher plants make their own food by a process called photosynthesis (see **Photosynthesis**). However, pitcher plants live in places where they get little of the nitrogen they need from the soil. The trapped insects provide extra nitrogen for the plants.

The principle of trapping insects is similar in all pitcher plants. Insects are attracted to pitcher plants by their bright colouring, strong smell, or by nectar secreted around the lip of the pitcher. Once an insect alights on the rim and goes inside the pitcher, it slides down the waxy inside wall into the rain water collected in the base of the pitcher. Downward-pointing hairs on the inside wall of the pitcher prevent the insect from escaping. The insect is digested by chemicals called enzymes, secreted by the plant into the rain water.

There are three families of pitcher plants, all of which live in warm regions. The 17 American species are found in marshy areas of the Atlantic and Pacific coasts of North America, and in northern South America. The pitchers, formed by the folded leaves, are narrow and range from 10 to 120 centimetres long.

**Pitcher plants** catch rain water in their tube-shaped leaves. Insects get trapped in the leaves and drown in the water.

About 70 species of pitcher plants form the Asian group. These plants grow in the tropics of southern Asia, Indonesia, and northern Australia. They grow as *epiphytes* (plants that grow on other plants) or as climbers. The pitchers develop from the ends of *tendrils* (modified leaves that look like small coils of wire), and have a lid projecting over the mouth. They are from 5 to 30 centimetres long. One species from Borneo can hold 2 litres of liquid.

The *flycatcher plant* grows in the drier parts of peaty swamps in Western Australia. The pitchers develop from the base of the leaves. They are about 5 centimetres long and have hairy ridges running down their sides.

**Scientific classification.** American pitcher plants are in the family Sarraceniaceae. Asian pitcher plants belong to the family Nepenthaceae. The flycatcher plant is the only member of the family Cephalotaceae. It is *Cephalotus follicularis.*

See also **Plant** (picture: Plants that eat insects).

**Pitjantjatjara** are an Australian Aboriginal people. Until fairly recent times, they lived in *nomadic* (wandering) family groups in a vast territory southwest of Lake Amadeus, in Northern Territory. This area, which covers the Musgrave, Petermann, and Rawlinson ranges, has few safe water holes or fertile valleys. The Pitjantjatjara, armed with spears and spear-throwers, but no boomerangs, were skilful foragers and hunters. They hunted kangaroo, snakes, and lizards for food. They also gathered grass seeds and edible plants.

The Ernabella mission in the Musgrave Range was set up in 1936 to preserve the Pitjantjatjara culture and language. The people now raise sheep. They design and weave woollen rugs and make moccasins. At Fregon and Amata in South Australia, they manage cattle stations as self-governing communities.

**Pitlochry** is a summer resort in Tayside Region in the Scottish Highlands. The town stands in the Grampian Mountains on the River Tummel, in pleasant wooded country. The Pitlochry Festival Theatre presents a season of six plays by Scottish dramatists or on Scottish themes, between April and October. The Pitlochry dam is a hydroelectric station on the Tummel. Salmon swim upstream past the dam via the 270-metre Fish Pass. The dam forms a lake called Loch Faskally. Pitlochry is in Perth and Kinross local government district. See also **Perth; Tayside.**


**The Pitlochry Festival Theatre** presents plays connected with Scotland throughout the summer.

**Pitman, Sir Isaac** (1813-1897), a British schoolmaster, invented *phonetic shorthand,* a system of rapid writing that uses 38 symbols to represent the sounds of vowels and consonants. This method proved much superior to older systems. It is used almost exclusively in Britain and Ireland, and revised versions of it are taught in many schools. Pitman published his first shorthand manual in 1837. He also published practice books, and founded a school at Bath to teach his system. He was born at Trowbridge, in Wiltshire, England. See **Shorthand.**

**Pitot tube.** See **Log** (The pitometer log).

**Pitt** is the family name of two British statesmen. They form one of the most illustrious father-son combinations in British political history.

**William Pitt** (1708-1778), Earl of Chatham, is chiefly remembered as the "organizer of victory" and empire builder during the Seven Years' War, and for his powerful defence of the rights of American colonists. His grandfather, Thomas Pitt, had helped build British trade in India.

Born in Westminster, the son of a member of the British Parliament, William Pitt attended Eton College and Oxford University. Because of poor health, he did not graduate from Oxford. In 1735, he entered Parliament. From the first, he distinguished himself by his fiery attacks on Sir Robert Walpole and on the practice of subsidizing troops from the German province of Hanover with British money. Pitt enjoyed great popularity, but he had little power for several years. He did, however, study the French military and economic structure, and in time gained a full knowledge of France.

In 1746, Pitt became paymaster-general of the forces. In this office, he showed great ability and unusual honesty. As the years went by, however, his position did not improve. In despair and frustration, he bitterly denounced both the government's war policy and the weakness of the House of Commons. This action led directly to Pitt's dismissal in 1755. But with the renewal of the war with France the following year, he returned to office as secretary of state. Again he criticized his colleagues, again he left office, and again he returned. "I know," he said, "that I can save the country, and that I alone can."

His task seemed insurmountable, for on every side he found defeat and confusion. But in five years, he gained great success. Pitt strengthened the British fleet and blocked French ports; he sent supplies to Frederick the Great of Prussia, and attacked France on all fronts. Great victories, especially in 1759, marked his policy everywhere. The French were defeated in America, Europe, India, the West Indies, and on the sea. But in spite of these victories, other ministers opposed his demand that the war be continued until France was completely defeated. He resigned in 1761.

During the next five years, Pitt resumed his opposition to the government. He denounced the Peace of

**William Pitt,** the Earl of Chatham, *left,* defended the rights of the English Colonies in America. His son, William Pitt the Younger, *right,* was one of England's greatest prime ministers.

Paris (1763) as far too lenient and aroused the British people to criticize the House of Commons. He denounced British policy toward the American colonists. This made him popular on both sides of the Atlantic.

Pitt was too powerful and too popular to remain out of office for long. In July 1766, he became prime minister and had his first opportunity at full control of the government. His ministry lacked unity, and he did both Great Britain and himself great damage by entering the House of Lords as the Earl of Chatham. He and his ministers proved incapable of solving troubles in America and India, and of governing Britain itself. Within a few months, Pitt became greatly depressed. After the resignation of his more dependable ministers, he let the direction of affairs fall into the hands of Charles Townshend. Pitt resigned in October 1768.

During the next 10 years, he had occasional periods of prominence. He supported parliamentary reform. He also studied the American situation, protested against British policy there, and rejoiced when America resisted that policy. At no time, however, did he gain much of a following. But he always remained capable of dominating his listeners, and his last speeches on the American war were among his best.

Pitt was most outstanding as a wartime leader. He had neither the patience nor the temperament for political manipulation, and he did not deal successfully with financial problems. But at the time that Pitt achieved his greatest fame, the ability to inspire generals and arouse people was more important than skill in making political deals and balancing the national budget.

**William Pitt the Younger** (1759-1806), the son of William Pitt, Earl of Chatham, became Britain's chancellor of the exchequer at the age of 23 and prime minister at 24. He was the youngest man ever to hold either post. He served as prime minister from 1783 to 1801 and from 1804 to 1806. He dominated British politics during the interval between these two terms.

Pitt was born in Kent, and entered Cambridge University at the age of 14. Because of poor health and his cold manner, he took no pleasure in his university experience. After graduation in 1780, he studied law. He was admitted to the bar, but his main interest lay in politics.

In January 1781, Pitt entered parliament. His amazing abilities quickly made him outstanding. His first speech, always one of the most difficult tests in politics, was remarkable. Many observers believed that Pitt showed ability equal to that of his father. In committee work, he was informed, penetrating, and self-possessed.

Almost immediately, Pitt began to press for parliamentary reform and a reduction of the influence of the king. He quickly gained favour with older politicians. In 1782 and 1783, he served as chancellor of the exchequer under Lord Shelburne.

In December 1783, Pitt became prime minister. He held this office for the next 17 years. During the first three months, he experienced great difficulty in the House of Commons because he had singlehandedly to meet the attacks of the opposition, led by Charles James Fox, Edmund Burke, Richard Brinsley Sheridan, and Lord North. Pitt's fellow cabinet members were all in the House of Lords. In March 1784, however, he called for a new election and scored a great triumph. This provided him with a majority in the House of Commons.

Pitt then turned his attention to improving the British economy. He increased the revenue, funded the debt, improved credit, and negotiated a free-trade treaty with France. He extended the authority of the British government over India. But Pitt also had troubles. Late in 1787, King George III became emotionally unbalanced because he suffered from a disease now called *porphyria,* and Pitt had to struggle against a Whig party campaign to name the Prince of Wales as regent. Pitt feared that, if the campaign succeeded, the Whigs would take over the government. George's recovery in 1789 relieved the situation.

A more important problem soon challenged Pitt—the French Revolution. At first, he failed to sense its significance. But his attitude changed when France declared war on Britain in February 1793. Pitt organized a vast coalition of European countries, both large and small, to fight France. After some successes, the alliance suffered military defeats. Several of the member nations seceded from the alliance. After the rise of Napoleon Bonaparte in France, the situation steadily grew worse. Pitt entered into peace negotiations with the French government, but was unsuccessful. The coalition came to a dismal end when Napoleon's smashing triumphs over Austria brought about the latter's withdrawal.

Because Britain was still at war with France, Napoleon sought to end his struggle by striking through Egypt and the Near East. Although defeated in this attempt and immediately faced by a second coalition, Napoleon soon scored a decisive victory. Pitt's strategy had failed again. British successes on the sea did not offset Napoleon's victories on land.

Pitt had resigned office a few months earlier over his failure to persuade George III to include voting rights for Roman Catholics in the Act of Union, which formed the Kingdom of Great Britain and Ireland in 1801. Pitt returned to office in 1804 to organize a third coalition of nations against Napoleon.

This coalition also fell before the French, and its failure proved disastrous to Pitt. He was sadly troubled already because of the king's increasing mental disorder and his own poor health and disorganized finances. He could not survive the military defeats of Britain's allies. Even Admiral Horatio Nelson's astounding victory over a combined French and Spanish fleet at the Battle of Trafalgar in 1805 could not make up for the losses. Though

Pitt could say "England has saved herself by her exertions, and will, I trust, save Europe by her example," he also recognized the significance of Napoleon's victory over the Austrian and Russian armies at Austerlitz. "Roll up the map," he said of a map of Europe, "it will not be wanted these ten years."

Pitt died on Jan. 23, 1806. He was buried in Westminster Abbey, in London.

**Pitta** is the name of about 20 *species* (kinds) of brightly coloured ground birds of the tropics of Africa, Asia, and Australasia. Most species are found in Southeast Asia. A pitta is a long-legged, stocky bird with a short tail and strong *bill* (beak). It lives in forests and feeds mainly on worms, snails and insects. A pitta's nest is large, and generally built less than 3 metres above the ground in a tree stump, tangled vegetation, or rock crevice. Several species of pittas are rare, and live in one small area, or a few areas.

**Scientific classification.** Pittas belong to the family Pittidae.

**Pitti Palace** is the largest palace in Florence, Italy. The palace was once of the home of the kings of Italy. Today, it houses one of the world's great collections of paintings, including works by Raphael, Titian, Rembrandt, and Peter Paul Rubens.

The palace was built for Renaissance merchant Luca Pitti and begun in 1458. The original architect is not known, but a major addition was built between 1560 and 1570 by Italian architect and sculptor Bartolommeo Ammannati. Later expansions took place between 1620 and 1640 and between 1764 and 1783, when large wings were added to the main front.

The most striking feature of the palace is its stern and impressive street facade, which is 36 metres high and 200 metres long. The front is built of enormous blocks of masonry. The Boboli Gardens, on the stepped terraces immediately behind the palace, are among the most beautiful in Italy.

**Pittosporum** is a *genus* (group) of small evergreen shrubs and trees. About 12 kinds grow in Australia. They also grow in New Zealand and in parts of Asia and Africa. The trees have tubular white or yellow flowers and sticky seeds in a hard fruit. Sweet pittosporum is a small tree with wavy leaves, yellow flowers, and red seeds.

**Scientific classification:** These plants belong to the family Pittosporaceae and the genus *Pittosporum*.

**Pittsburgh** (pop. 369,879; met. area pop. 2,054,705), Pennsylvania, U.S.A., is one of the great steelmaking centres of the world. The Pittsburgh area provides about 10 per cent of the steel produced in the United States each year. But since the mid-1900's, the steel industry has declined while service industries have grown in the city. Pittsburgh's economy still depends on steelmaking, but the city has also become an important centre of computer services and health care.

Pittsburgh lies in southwestern Pennsylvania, where the Allegheny and Monongahela rivers join to form the Ohio River. These rivers have helped make the city the centre of the state's inland waterway system. Among the cities in Pennsylvania, only Philadelphia has more people.

In 1758, British troops under General John Forbes built Fort Pitt near the fork of the Allegheny and Monongahela rivers. The military post was named after William Pitt, then prime minister of Great Britain. British settlers established a community outside the fort, and Forbes named it Pittsburgh.

**The city.** Pittsburgh factories line the banks of the Allegheny, Monongahela, and Ohio rivers. The area between the Allegheny and the Monongahela, near the fork of these two rivers, is called the *Golden Triangle.* Almost every major Pittsburgh company has its headquarters in this wedge-shaped central business district. Stainless steel skyscrapers rise from the 9-hectare Gateway Center, an office complex. The centre faces the 14.6-hectare Point State Park at the western tip of the triangle. The 64-storey United States Steel Building is the tallest structure in Pennsylvania. The Civic Arena stands east of the business area. Its domed roof can be slid back and forth, so that events may be held either indoors or in the open air.

Pittsburgh has over 720 bridges—more than any other U.S. city. Its residential areas lie on the rolling hills beyond the business and manufacturing districts. The hills and valleys have helped create many of Pittsburgh's neighbourhoods. Buses and cable cars carry passengers up and down the steepest hills. Two cable car lines take passengers 120 metres up from the river level and offer fine views of the city. Like most other large industrial cities, Pittsburgh has slums. These areas contrast sharply with the city's more prosperous suburbs.

**People.** About 95 per cent of Pittsburgh's people were born in the United States. The city has many residents of German, Irish, Italian, or Polish ancestry. Other groups include those of English, Hungarian, or Russian descent. Blacks make up about a fourth of the city's population.

During the 1960's and early 1970's, Pittsburgh's housing ranked among the worst in the United States. Almost a fourth of its dwellings were substandard. Many of the worst ones have been replaced or repaired, but large numbers of Pittsburgh blacks still live in crowded slums.

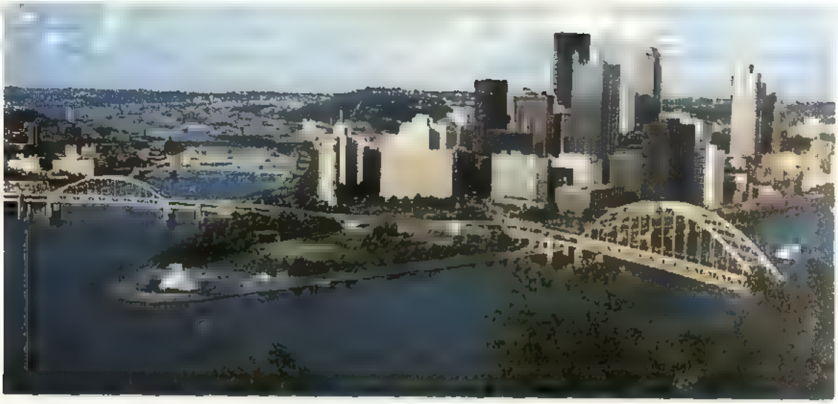
**Economy.** The 2,500 manufacturing plants in the Pittsburgh metropolitan area produce about 5 billion U.S. dollars worth of goods a year. Pittsburgh's importance as an industrial centre is closely related to the rich natural resources of the surrounding area. Steelmaking, still the chief manufacturing activity, depends heavily on coal. The mines of western Pennsylvania produce about 59 million metric tons of coal yearly. About 15 per cent of this total goes to steel mills in the Pittsburgh area.

The Pittsburgh area manufactures nearly a fifth of the United States' pig iron and about a fifth of its coke. The area also ranks high in the production of bottles, plate glass, and window glass. Other leading industries make chemicals, electrical equipment, fabricated metals, food and food products, and machinery.

Service industries, especially computer services and health care, have become an important part of Pittsburgh's economy.

**History.** Iroquois Indians lived in the Pittsburgh area before white settlers arrived. Attempts by France and Great Britain to gain control of the region led to the French and Indian War (1754-1763).

The British won control of the area in 1758 and built Fort Pitt near the fork of the Allegheny and Monongahela rivers. The settlement that formed around the fort became Pittsburgh. After the American Revolution (1775-1783), Pittsburgh became a starting point for pioneers



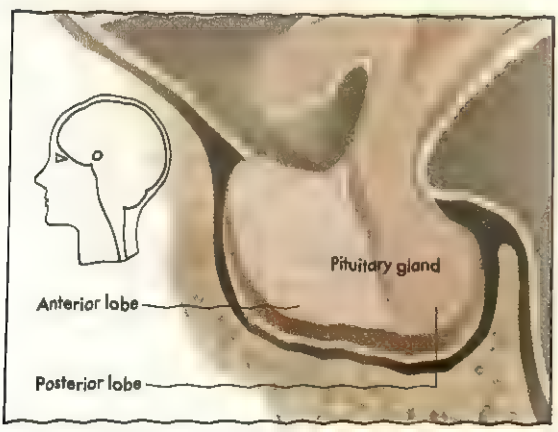
**Central Pittsburgh** lies in a triangle-shaped area bordered by two rivers, the Allegheny, *left,* and the Monongahela, *right.* The area at the tip of the triangle is the 14.6-hectare Point State Park.

travelling west. It was called the *Gateway to the West* and grew as a trading and boat-building centre.

Demands for manufactured goods from the Western settlements caused industry to grow rapidly in Pittsburgh. Many of its industries, including glass and iron, began around 1800. During World War II (1939-1945), Pittsburgh's mills produced more steel than Germany and Japan together.

**Pituitary gland** is one of the body's most important glands. It secretes a number of hormones, which control a wide range of body functions. The pituitary gland is about the size of a pea and lies under the brain, near the centre of the skull. A short stalk connects it to the *hypothalamus,* a part of the brain. The pituitary gland is sometimes called the *hypophysis.*

The pituitary has two main sections—the *anterior lobe* (front part) and the *posterior lobe* (rear part). The anterior lobe secretes several hormones. Four of these hormones control the secretions of other hormone-producing glands. The four hormones and the glands they control are: *adrenocorticotrophic hormone* (ACTH), the adrenal glands; *follicle-stimulating hormone* (FSH) and *luteinizing hormone* (LH), the sex glands; and *thyroid-stimulating hormone* (TSH), the thyroid gland. The pituitary is often called the *master gland* because it regulates these other glands.




**The pituitary gland** is one of the body's chief *endocrine* (hormone-producing) organs. It consists of two main parts—the anterior lobe and the posterior lobe—and it rests in a bony depression. A short stalk connects the pituitary to the brain.

The anterior lobe of the pituitary also produces *growth hormone* (GH), which regulates the growth of children and adolescents. Growth hormone also helps control the way food is utilized in people of all ages. *Prolactin,* another hormone of the anterior lobe, stimulates milk production in nursing mothers.

The hypothalamus plays an important role in regulating the anterior lobe of the pituitary. It produces various *releasing hormones* that govern the release of the anterior-lobe secretions.

The posterior lobe of the pituitary gland stores two hormones, *antidiuretic hormone* (ADH, also called *vasopressin*) and *oxytocin.* The hypothalamus manufactures and triggers the release of both these hormones. Antidiuretic hormone causes the kidneys to retain sufficient water for the body. Oxytocin causes the uterus to contract during childbirth and stimulates the release of milk during nursing.

See also **ACTH; Dwarf; Endorphin; Giant; Gland; Human body** (Trans-Vision picture); **Hypothalamus.**

**Pius IV** (1499-1565) was elected pope in 1559. He successfully put into effect many key reform measures of the church renewal movement called the Counter Reformation. His major achievement was reconvening the Council of Trent. The council had been suspended in 1552, and Pius reopened it in 1562. Pius was a shrewd and diplomatic man, and he used these qualities to help the council complete its business in 1563. The council established the basic framework of Roman Catholic reform (see **Trent, Council of**). Pius also reformed the Roman Curia, the pope's administrative arm.

Pius helped revive the cultural and intellectual life of Rome and had several notable structures built, including the Porta Pia arch and the Villa Pia in the Vatican gardens. In his endeavours, Pius relied on the aid of his nephew, Saint Charles Borromeo. Pius was born in Milan, Italy. His original name was Giovanni Angelo de Medici.

**Pius V, Saint** (1504-1572), was elected pope in 1566. He typified the intense religious feeling of Roman Catholicism during the church renewal movement called the Counter Reformation. Pius was solemn, devout, and ascetic. As pope, he tried to impose rigid standards of piety and morality on both clergy and lay people. He

worked to put into effect the reforms established by the Council of Trent by publishing the Roman Catechism and other important devotional documents (see **Trent, Council of**).

Pius was an uncompromising enemy of Protestantism. He was equally determined to stop the advance of Islam. He formed the Holy League with Venice and Spain that won a dramatic victory over the Muslim Turks at the Battle of Lepanto in 1571.

Pius was born in Bosco, near Alessandria, Italy. His original name was Michele Ghislieri. He became a Dominican friar at the age of 14. He was *canonized* (declared a saint) in 1712. His feast day is April 30.

**Pius VII** (1742-1823) was elected pope of the Roman Catholic Church in 1800. He was pope during the difficult years that Napoleon I of France controlled much of central and western Europe, and during the European settlement that followed Napoleon's defeat in 1815. At first, Pius followed a conciliatory policy with Napoleon. He made an agreement with Napoleon that settled the confused French religious problem. The agreement guided church-state relations in France for more than 100 years. In 1804, Pius went to Paris to crown Napoleon emperor.

However, as Napoleon increased his demands, Pius stiffened his resistance. He refused to join the continental blockade against England, and he refused to grant Napoleon a divorce from Josephine. In 1809, Napoleon annexed the Papal States. Pius excommunicated all who took part in this action. He was arrested and held in Fontainebleau until 1814. Pius' strong stand against Napoleon won him the admiration of the European powers. They supported his bid to reclaim the Papal States after Napoleon's defeat.

Pius was born in Cesena, Italy. His original name was Gregorio Luigi Barnaba Chiaramonti. He became a Benedictine monk at the age of 14. Pope Pius VI named him a cardinal in 1785.

**Pius IX** (1792-1878) was elected pope of the Roman Catholic Church in 1846. He enjoyed the longest reign in papal history. His early acts as pope promised a liberal and popular government for the Papal States. He pardoned political prisoners, admitted lay people to the government, and promised a constitution. He fled Rome in 1848 when revolutionaries made the city a republic. After his restoration in 1850, Pius followed a highly conservative policy in government matters.

In 1854, Pius defined the doctrine of the Immaculate Conception of the Virgin Mary as an article of Roman Catholic dogma (see **Immaculate Conception**). Ten years later, he issued the *Syllabus of Errors,* a collection of propositions that gave the impression that he was opposed to all progress and to modern civilization.

The outstanding event of Pius IX's reign was the assembling of Vatican Council I in 1869, the first general council since the 1500's. The council declared that the pope had *primacy of jurisdiction*—that is, he was first in importance—over the whole church. The council also approved the doctrine of *papal infallibility.* For a description of this doctrine, see **Vatican Council** (Vatican I).

Italy took the Papal States and Rome by force during the unification in the 1860's and 1870's. Pius became a voluntary prisoner in the Vatican. He refused any accord that did not recognize him as a sovereign ruler. He believed that he would be looked on as "the Italian king's chaplain" if he settled for anything less. See **Italy** (Italy united).

Pius was born in Senigallia, Italy. His original name was Giovanni Maria Mastai-Ferretti. He was ordained a priest in 1819, created an archbishop in 1827, and made a cardinal in 1840. As archbishop of Imola, he was noted for his liberal sympathies and his criticism of the conservative Pope Gregory XVI.

**Pius X, Saint** (1835-1914), was elected pope of the Roman Catholic Church in 1903. Pius was theologically conservative. In 1907, he issued an *encyclical* (letter to the entire church) and other statements condemning *Modernism.* Modernism was a general trend to adopt new theological methods and to apply historical criticism to the Scriptures. Pius had an important impact on Catholic spiritual life. He encouraged frequent reception of the Eucharist, admitted children of the age of reason to Communion, and encouraged the use of the Gregorian chant in the liturgy.

Pius was born in Riese, near Treviso, Italy. His original name was Giuseppe Melchiorre Sarto. He was ordained a priest in 1858. In 1893, Pope Leo XIII named him patriarch of Venice and a cardinal. Pius was widely regarded as a saint during his lifetime. He was *canonized* (declared a saint) in 1954.

See also **Roman Catholic Church** (The church today).

**Pius XI** (1857-1939) was elected pope of the Roman Catholic Church in 1922. In 1929, he negotiated the Lateran Treaty that ended a long conflict between the papacy and the Kingdom of Italy called the "Roman question." The treaty gave the pope sovereignty over Vatican City (see **Papal States**). Pius was increasingly confronted by the rise of totalitarian governments in Europe. In 1931, he issued an *encyclical* (letter to the entire church) condemning Italian Fascism. He negotiated a *concordat* (agreement) with Nazi Germany in 1933, but he condemned both Nazism and Communism in separate encyclicals in 1937. However, in 1936, he supported dictator Francisco Franco in the Spanish Civil War against the republican government's increased persecution of the Catholic Church.

Pius was born in Desio, near Milan, Italy. His original name was Ambrogio Damiano Achille Ratti. He was ordained a priest in 1879, and Pope Benedict XV named him a cardinal in 1921.

**Pius XII** (1876-1958) was elected pope of the Roman Catholic Church in 1939. He was one of the most active popes in church history. Pius used his authority to such an extent that he was sometimes criticized within his church for determining too many issues. But he was widely praised for the broad range of his interests and his brilliance in attacking basic church problems.

Pius negotiated with the heads of several European governments to try to prevent World War II, and to end the war as soon as possible after it began in 1939. He is credited with saving at least 800,000 Jews from death by the Nazis through secret arrangements. After his death, some people blamed Pius for not having spoken out more forcefully against the Nazi persecution of the Jews. Other people believe that Pius felt further appeals to Adolf Hitler were useless and that such appeals might have increased the Nazi persecution of Jews in Italy.

In the area of church teaching, Pius in 1950 proclaimed the Assumption of the Blessed Virgin into heaven. His *encyclical* (letter to the entire church) called *Mediator Dei* (1947) prepared for the updating of the Catholic Mass in the 1960's. He altered some customs, such as shortening Holy Week ceremonies and relaxing the law of fasting before Holy Communion.

Pius was born in Rome. His original name was Eugenio Pacelli. He was ordained a priest in 1899 and was named a cardinal in 1929. He served as papal secretary of state from 1930 until his election as pope.

See also **Pope** (picture: Pius XII).

**Pizarro, Francisco** (1478?-1541), was a Spanish conqueror. His conquest of the Inca empire opened the way for Spain's colonization of most of South America.

**Early life.** Pizarro was born in Trujillo, Spain. His father was a royal captain of infantry. Francisco's parents never married each other. Poor relatives of his mother raised the boy, who never learned to read. In 1502, Pizarro left for the West Indies. He lived for a while in Hispaniola, the main Spanish base in the New World. He may have been aided by a brother of his father's who was already in the West Indies.

**First expeditions.** In 1509, Pizarro left Hispaniola to take part in exploration of the Caribbean coast of northern South America and southern Central America. He served as Vasco Núñez de Balboa's chief lieutenant (see **Balboa, Vasco Núñez de**). Six years later, the Spaniards founded Panama City on the Pacific coast. Pizarro was one of its wealthiest and most powerful citizens.

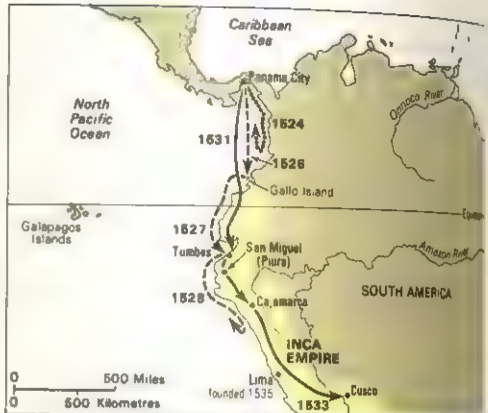
The Spaniards in Panama City became interested in reports of a rich Indian empire somewhere to the south. In 1524, Pizarro began the first of several expeditions to search for this empire. He was helped by another Spaniard, Diego de Almagro, who served chiefly as business manager of the expeditions. Pizarro led the explorations down the Pacific coast. At first, bad weather and Indian attacks prevented the voyagers from finding the empire, which was centred in what is now Peru. Pizarro finally reached his goal in late 1527 or early 1528.

**Conquest of Peru.** Pizarro saw much evidence of gold and other riches in Peru. He soon returned to Spain, and King Charles I appointed him governor of Peru. In 1531, Pizarro sailed from Panama City with about 180 men. They landed in what is now Ecuador. In 1532, they founded San Miguel (now Piura) in northern Peru.

Pizarro next advanced to Cajamarca, where the Inca ruler Atahualpa had gathered his forces. In a surprise attack with swords, horses, and a few guns, Pizarro's men captured Atahualpa and killed thousands of Incas. The Spaniards promised to spare Atahualpa's life in return for vast riches. The Incas were able to agree to the ransom because Peru had more silver and gold than any other part of the Americas. But in 1533, after receiving a large treasure, the Spaniards executed Atahualpa (see **Atahualpa**). Pizarro then advanced on Cusco, the Inca mountain capital, and took control of the city.

**Later life.** In 1535, Pizarro founded the city of Lima and made it Peru's capital. While he was governor of Peru, many Spaniards settled there. The settlers started mining great amounts of silver and gold and began to build many cities. Using Peru as its base, Spain conquered most of the rest of South America.

In the late 1530's, a dispute between Pizarro and Almagro over who was to rule the area around Cusco led to war. Pizarro's forces won the conflict in 1538 and executed Almagro. In 1541, followers of Almagro's son killed Pizarro.




**Pizarro's expeditions** led to the Spanish conquest of the Inca empire in 1533. Pizarro began to look for the empire in 1524 and finally found it in Peru about four years later.

See also **Inca** (History); **Peru** (History).

**Pizza.** See **Food** (table: Interesting facts about food); **Naples** (The people).

**PKU.** See **Phenylketonuria.**

**Plaatje, Solomon Tshekisho** (1875?-1932), was a black South African writer and political leader. He was a founder member of the African National Congress and its first secretary (see **African National Congress**).

Plaatje's works include *A Boer War Diary,* published in 1973, which records his experiences during the siege of Mafikeng. *Native Life in South Africa* (1916) is an account of the effects of the Natives' Land Act of 1913. *Mhudi* (1930) was the first novel in English by a black South African.

Plaatje was born near the small Orange Free State town of Boshof. Although educated to primary school level, he taught himself eight languages. Plaatje worked as a court interpreter, newspaper editor, and writer. He publicized the plight of black South Africans.

**Place value.** See **Numeration systems.**

**Placebo** is a substance that doctors sometimes use as a medicine, even though it contains no active ingredient. A placebo brings about an improvement or even a cure in some patients. Placebos look like real drugs, but most consist only of sugar or a salt solution. Doctors sometimes use placebos as they would any drug, with a positive effect in about 30 per cent of the patients. Improvement brought about in this way, by a non-active substance is known as the placebo effect.

Doctors believe the effectiveness of placebos depends on the patient's belief that the substance being administered is actually beneficial. In many cases, this belief provides a psychological boost that can improve the patient's condition.

Placebos are also used in research into the effectiveness of new drugs. One group is given a new drug, and a *control* group with the same illness receives a placebo. Researchers then determine what changes occur among only the patients who get the new drug.

**Placenta** is a disc-shaped organ that develops in pregnant women. The placenta provides the unborn baby with food and oxygen and carries away the baby's waste products. The organ also produces chemicals called *hormones,* which maintain the pregnancy and help regulate the baby's development.

The placenta consists of tissue from both the mother and the embryo. After the first week of pregnancy, the embryo fastens itself to the wall of the *uterus,* the organ in which the baby develops. The placenta forms as columns of cells from the *chorion*—the baglike covering that encloses the embryo—penetrate and break down the uterine lining. Inside the columns are blood vessels that branch into tiny, fingerlike projections called *villi.* The villi, which contain the baby's blood, are surrounded by the mother's blood. The blood of the baby and of the mother do not mix.

Food and oxygen from the mother's blood pass through the thin walls of the villi and enter the baby's blood. This food- and oxygen-rich blood reaches the baby through a vein in the *umbilical cord,* a flexible tube that connects the baby to the placenta. Waste products from the baby are carried through arteries in the umbilical cord and pass through the villi. The mother's circulatory system then gets rid of these wastes.

Minutes after the baby is born, the placenta separates from the uterus. Powerful contractions of the uterus expel the placenta, which may now be called the *afterbirth,* from the mother's body.

**Plagiarism** is the act of presenting another person's literary, artistic, or musical work as one's own.

Plagiarism is regarded as unethical. The copyright laws of many nations make plagiarism and other unauthorized copying a crime punishable by fine or imprisonment. In addition, the creator of a copyrighted work may sue anyone who plagiarizes it.

Plagiarism does not include the adoption of character types, general plots, or other ideas from existing works.

Plagiarism also does not normally include the copying allowed under the *fair use principle* of copyright law. This principle permits limited reproduction of another person's work without permission for such purposes as teaching, research, news reporting, or criticism.

See also **Copyright.**

**Plague, Bubonic.** See **Bubonic plague.**

**Plaice** is a commercially important flatfish of European waters. It grows to about 90 centimetres long and is brown with distinct orange spots on its right (upper) side. The skin is smooth. Plaice generally live on the seabed in shallow waters. Young plaice live in extremely shallow waters. Adult plaice are found as deep as 120 metres.

**Plaice** is a flatfish which lives on the seabed. Its colouring blends with the shells and the pebbles.

Plaice eat mainly invertebrates, such as molluscs and worms. Mature plaice also take other fish, including eels. Plaice are fished commercially in large numbers in the North Sea and around Iceland.

**Scientific classification.** The plaice belongs to the family Pleuronectidae. It is *Pleuronectes platessa.*

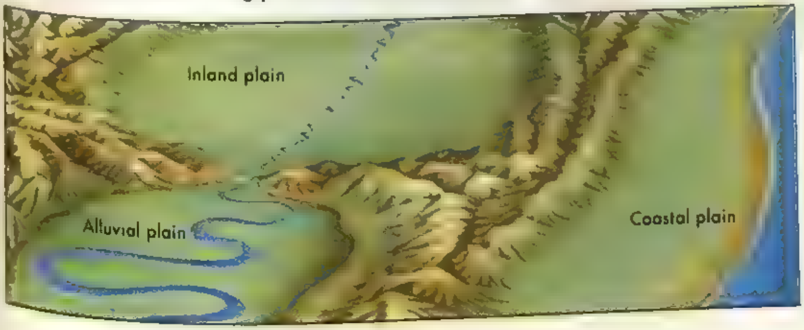
**Plaid.** See Tartan.

**Plain** is a broad, nearly level stretch of land with no abrupt changes in elevation. Plains are generally lower than the land around them. They may be found along the coast or inland.

Many plains, such as the Great Plains in the United States, have few trees because of dry or cold climates. Thick forests usually thrive on plains in humid climates. Plains are usually well populated because the soils are often rich and good for farming, and because buildings and roads are easy to build on the level terrain.

***Alluvial plain*** or ***flood plain*** is a plain formed of mud and sand left by the overflow of a river. Floods in high regions carry off quantities of earth and other matter. They leave this material lower down on the plains when they flood the river valley. The overflow waters lie still on the land surface and a natural deposit occurs. The world's largest alluvial plain is the region of the valleys of the Brahmaputra, Ganges (Ganga), and Indus rivers in India and Bangladesh.

***Coastal plain*** is a stretch of lowland along a seacoast, which slopes gently toward the sea. In many cases such




**Kinds of plains**

The illustration on the left shows some of the chief kinds of plains. *Alluvial* or *flood plains* are formed of mud and sand left by the overflow of a river. *Coastal plains* are lowlands that slope gently toward the sea. *Inland plains* occur in the interior of a land mass, usually at higher altitudes than coastal plains.

a plain may once have been below sea level. It is made up of material washed down from mountain streams to become part of the land area of the continent.

The *Atlantic Coastal Plain* is a good example of a fertile and well-populated coastal plain. It lies along the eastern shore of North America from Canada to Mexico. Many coastal plains have few and poor harbours, but the rising sea level has produced some fine bay harbours in parts of the Atlantic Coastal Plain. The sharp slope that marks the line between the other land and the coastal plain is called the *Fall Line.*

**Related articles** in *World Book* include:

| | | |
|---|---|---|
| Great Plains | Plateau | Steppe |
| Pampa | Prairie | Tundra |
| Peneplain | | |

**Planarian** is a type of flatworm. Different kinds of planarians live in streams, lakes, seawater, or damp soil. Most planarians have flat, elongated bodies with a rounded or triangular head and measure 7 to 35 millimetres long. Some may grow to 35 centimetres.

Planarians feed on other small animals or on dead animal matter. Grooves or pits on each side of the head can sense food.

Planarians lay fertilized eggs in cocoons. The young worms that hatch look like small adult worms. Many planarians can also reproduce by simply dividing into pieces. Each piece then can develop into a complete new adult. Planarians have remarkable abilities to *regenerate* (regrow) any lost or damaged parts of their bodies.

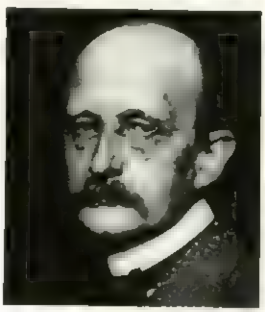
**Scientific classification.** Planarians belong to the order Tricladida of the class Turbellaria in the phylum Platyhelminthes.

See also **Flatworm.**

**Planck, Max Karl Ernst Ludwig** (1858-1947), was a German theoretical physicist who concentrated on the study of thermodynamics. He was concerned with the phenomena of absorption and emission of heat and other kinds of radiant energy. In 1900, he originated the *quantum theory* when he proposed his law of radiation. This new theory revolutionized physics. In 1918, Planck was awarded the Nobel Prize for physics.

The major concept involved in Planck's theory was that an object that completely absorbs radiant energy, known to scientists as a *black body,* can absorb or emit energy only in tiny irreducible bits called *quanta.* The energy of each quantum is measured by multiplying the frequency of the radiant energy, $\nu$, by a universal constant, $h$. The constant is known as *Planck's constant.* Thus, energy $(E)$ equals $h\nu$. For example, a red flame emits less energy—that is, it is cooler—than a blue flame because red light has a lower frequency than blue light.

Planck's concept of energy quanta disagreed with former ideas about the nature of energy. Scientists had thought that energy flowed continuously. This view, however, could not explain the absorption and emission of energy by matter. Planck's theory accounted for this.



Granger Collection

**Max Planck**

In 1905, the German-born physicist Albert Einstein independently introduced the concept of light quanta (see **Einstein, Albert**). In 1913, the Danish physicist Niels Bohr introduced quantum ideas into atomic theory and originated the modern theory of atomic structure (see **Bohr, Niels**).

Planck was born in Kiel, Germany. He studied at the universities of Munich and Berlin, and taught physics at the universities of Munich, Kiel, and Berlin.

See also **Light** (Quantum mechanics); **Quantum mechanics; Radiation** (The quantum theory); **Science** (picture).

**Plane.** See Aeroplane.

**Plane geometry.** See Geometry.

**Plane table** is an instrument used in surveying and mapmaking. It consists of a drawing board mounted on a *tripod* (three-legged stand). The drawing board is levelled, and a map is placed on it. An *alidade* (telescope fastened to a straightedge) is set up on the map. The telescope and straightedge move parallel with one another. The mapmaker sights an object through the telescope and can use the straightedge to draw a line on the map parallel to the line of sight. By using various lines of sight, the mapmaker is able to locate different points and then use these points to construct a map.

**Plane tree** is one of several species of large trees with flaking bark, bristly spherical seedballs, and long-stalked palmate leaves.

The *American sycamore,* also known as buttonwood, is a common riverside tree of the eastern United States. It can grow to over 45 metres. The *oriental plane* from southeastern Europe and Asia grows to 30 metres, often with large, rounded trunks. The *London plane* is a hybrid of the American and the oriental plane, and is of intermediate height.

Plane trees grow quickly. They are planted as shade trees and for their attractive, flaky bark.

**Scientific classification.** The American plane is *Platanus occidentalis,* the oriental plane is *P. orientalis,* and the London plane is *P.* × *hispanica* 'Acerifolia'.

**The London plane tree** grows beside many streets in London. It can tolerate a high level of air pollution.

**The planet earth as viewed from space.** To an astronaut orbiting the earth, there is no up or down, north or south. Africa might therefore appear on the right, Antarctica on the left, and the Atlantic and Pacific oceans at the top and bottom, as seen here.

# Planet

**Planet** is any one of the nine largest objects that travel around the sun. Going outward from the sun, the planets are Mercury, Venus, the earth, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto. Pluto is generally considered the farthest planet from the sun, though between 1979 and 1999 its path brought it closer to the sun than Neptune. The sun, the planets and their *satellites* (moons), and smaller objects called asteroids, comets, and meteoroids make up the *solar system.*

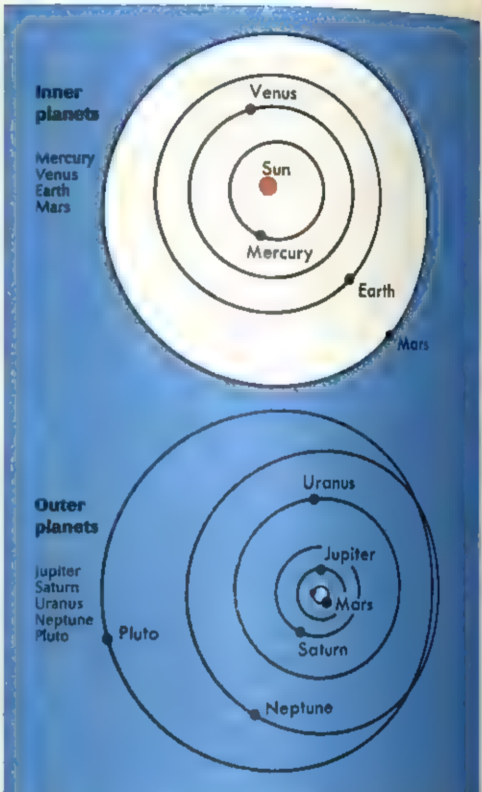
The sun and the other stars are giant, shining balls of hot gases. The planets are dark bodies, much smaller than the sun and most stars. The main difference between the stars and the planets is that the stars produce their own heat and light, but the planets do not. Nearly all the light and heat that reaches the planets comes to them from the sun. The planets can be seen only because they reflect the light of the sun. Six of the planets—Mercury, Venus, Mars, Jupiter, Saturn, and Uranus—are bright enough to be seen from the earth without the aid of a telescope.

Planets and stars look much alike in the night sky, but there are two ways to tell them apart. First, the planets shine steadily, but the stars seem to twinkle. Second, the planets move in relation to the stars. This movement was first noted by the ancient Greeks, who called the moving objects *planetae,* from *planetes,* meaning *wanderer.* Modern astronomers using telescopes have found a third way to tell stars and planets apart. All planets except Pluto appear as a disc. But stars, in a correctly focused telescope, always look like points of light.

The planets differ greatly in size and in distance from the sun. All of them together weigh less than a hundredth as much as the sun. The diameter of Jupiter, the largest planet, is about a tenth of the sun's. Yet Jupiter is more than 60 times as large as Pluto, the smallest planet. The earth and the three other planets nearest the sun are somewhat similar in size. They are called the *terrestrial* (earthlike) planets, or *inner* planets. The four largest planets, called the *giant* or *major* planets, are much farther from the sun. The giant planets, together with Pluto, are often called the *outer* planets.

Suppose the solar system were shrunk so that the sun were the size of a tennis ball. If you placed the sun in the middle of a large field, all the terrestrial planets could be placed in the field within 10.5 metres of the sun. Jupiter, the largest of the planets, would be the size of a pea 6.5 millimetres in diameter and would be 36.3 metres from the sun. Pluto, usually the most distant of the planets, would be 275 metres from the sun. If an observer could look at the real sun from the position of the real planet Pluto, he or she would see no more than an extremely bright star.

Astronomers do not now think there are any planets in the solar system beyond Pluto. But they are almost certain that many of the stars in the universe have planets travelling around them. There are hundreds of billions of stars in the *Galaxy* (our family of stars, which includes the sun), and over 100 billion other galaxies can be seen in the universe. Suppose one star in every galaxy had a planet like the earth, and intelligent life existed on one out of every million of these planets. There would be a hundred thousand planets with intelligent life.

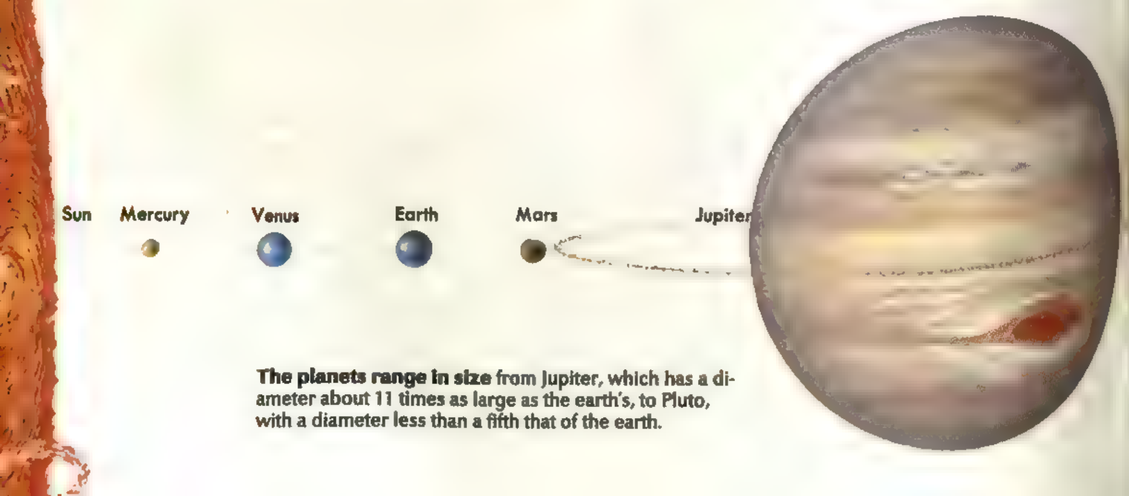



**The orbits of the planets** around the sun are shown above. Two diagrams are needed because the orbits of the outer planets would extend off the page if they were drawn to the same scale as those of the inner planets.

### How the planets move

As seen from the earth, the planets and the stars move westward across the sky. A person using a telescope to observe a planet must turn it constantly to keep the planet in view. From night to night, in addition to its motion across the sky, each planet shifts its position slightly eastward in relation to the stars. At certain times, a planet's position may temporarily shift westward, but it always returns to its regular eastward shift.

**Orbiting the sun.** If we could look down upon the solar system from the north, we would see that most of the planets travel around the sun at more or less the same level in space. Astronomers say that the planets orbit the sun in the same plane. Only two planets, Mercury and Pluto, follow paths that are inclined at significant angles to this plane. Mercury's path has an inclination of 7° to the orbital plane, and Pluto's has an inclination of 17°. From our position to the north of the solar system, we would see that all the planets travel around the sun in an anticlockwise direction. Three laws




**The planets range in size** from Jupiter, which has a diameter about 11 times as large as the earth's, to Pluto, with a diameter less than a fifth that of the earth.

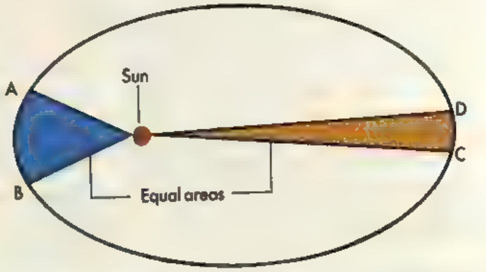

**The axes of the planets,** represented by the solid lines *above,* are imaginary lines around which the planets rotate. A planet's axis is not perpendicular to the path of the planet's orbit around the sun. It tilts at an angle from the perpendicular position indicated by the broken line.

of planetary motion describing the orbits of the planets were published in the early 1600's by the German astronomer and mathematician Johannes Kepler.

*Kepler's first law* says that the planets move in *elliptical* (oval-shaped) orbits. As a result, the planets are a little closer to the sun at some points in their orbits than at others. For example, the earth comes within 147,100,000 kilometres of the sun at its *perihelion* (point of the orbit nearest the sun). It goes 152,100,000 kilometres from the sun at its *aphelion* (point farthest from the sun).

*Kepler's second law* is also called the *law of areas.* It says that an imaginary line between the sun and a planet sweeps across equal areas of space in equal periods of time. When a planet is at its closest to the sun, it is moving at its fastest speed. In a given time—for example, ten days—the line joining the planet to the sun sweeps across a short, thick slice of space, which we will call Area 1. When the same planet is at its farthest, it is travelling at its slowest speed. In a ten-day period, the line now sweeps across a long, thin slice of space, which we will call Area 2. Although the dimensions of the two slices are different, careful measurement shows that Area 1 equals Area 2.

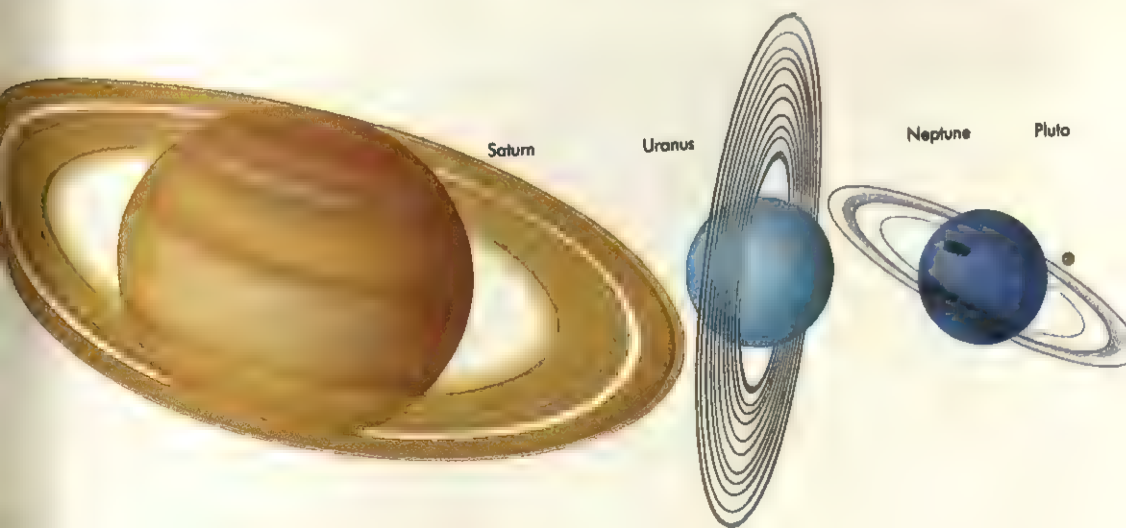
*Kepler's third law* says that a planet's *orbital period* (the time required for it to go once around the sun) depends on its average distance from the sun. According to this law, the square of the period (the period multiplied once by itself) divided by the cube of the distance (the distance multiplied twice by itself) is the same for all the planets. Thus, a planet four times as far from the sun as another planet takes eight times as long to orbit the sun. This law was once used to find a planet's average distance from the sun after its orbital period had been measured.




**Kepler's second law** shows how a planet covers equal areas of its orbit in equal periods of time. The planet travels at a higher speed near the sun, from *A* to *B*, than far from the sun, *C* to *D*.

**Rotation.** Each planet *rotates,* or spins, as it revolves around the sun. The planets' *rotation periods* (the times required for individual planets to complete one spin) range from less than 10 hours for Jupiter to 243 days for Venus. The earth rotates once every 24 hours, or one day (see **Earth** (How the earth moves; illustration: Three motions of the earth)).

Each planet spins about its *rotational axis,* an imaginary line through its centre. None of the planets has a rotational axis that is precisely *perpendicular* (at an angle of 90°) to the path of its orbit. The axis of each planet tilts at an angle from the perpendicular position. The earth's axis, for example, tilts at about 23½° away from the perpendicular. But other planets have quite different angles of axial tilt. Mercury's axial tilt is less than 1°, in other words almost perpendicular to its orbit. Uranus's axial tilt is about 98°, with the axis lying almost parallel to the planet's orbital path. The axial tilt of Venus is about 178°, which means that the north and south poles



of the planet are almost reversed compared with those of planets such as the earth or Mars. The tilting of a planet's axis results in first one pole and then the other facing toward the sun during the planet's orbit. This gives rise to uneven heating of the planet and to seasons. See **Season**.

### Conditions on the planets

The temperature, atmosphere, surface features, length of days and nights, and other conditions on the planets differ widely. They depend on three things: (1) the planet's distance from the sun, (2) the planet's atmosphere, and (3) the planet's rotation.

**Temperature.** The planets nearest the sun receive more heat than those far away from it. The temperature on the closest planet, Mercury, rises to about 340° C during the day. On the earth, which is about 2½ times as far from the sun as Mercury, the daytime temperature averages only about 16° C. Pluto is over 100 times as far from the sun as Mercury. The temperature there is probably lower than −180° C.

The temperature on a planet is estimated from measurements of *infrared radiation* (heat waves) and radio waves that the planet sends out. These measurements are difficult to make for objects with low temperatures. For this reason, temperature estimates for cold planets are less reliable than those for warm planets.

**Atmosphere** is the mixture of gases that surrounds a planet. The atmospheres of the terrestrial planets consist chiefly of carbon dioxide and nitrogen. The atmospheres of the major planets consist mostly of helium, hydrogen, methane, and ammonia. The earth is the only planet that has a large amount of oxygen in its atmosphere.

Astronomers determine the kinds of gases in a planet's atmosphere by analysing the light, radio waves, and other radiation coming from the planet. Different chemicals absorb different parts of this radiation, so, by seeing which parts are missing, astronomers can work out which chemicals are present in a planet's atmosphere.

The *atmospheric pressure* (force exerted by the weight of gases) on a planet's surface depends on the

## The planets at a glance*

| | Mercury ☿ | Venus ♀ | Earth ⊕ | Mars ♂ |
|---|---|---|---|---|
| Distance from the sun: | | | | |
| Mean | 35,980,000 mi. (57,900,000 km) | 67,230,000 mi. (108,200,000 km) | 92,960,000 mi. (149,600,000 km) | 141,000,000 mi. (227,900,000 km) |
| Shortest | 28,600,000 mi. (46,000,000 km) | 66,800,000 mi. (107,500,000 km) | 91,400,000 mi. (147,100,000 km) | 128,400,000 mi. (206,600,000 km) |
| Greatest | 43,400,000 mi. (69,800,000 km) | 67,700,000 mi. (108,900,000 km) | 94,500,000 mi. (152,100,000 km) | 154,800,000 mi. (249,200,000 km) |
| Closest approach to Earth | 57,000,000 mi. (91,700,000 km) | 25,700,000 mi. (41,400,000 km) | — | 34,600,000 mi. (55,700,000 km) |
| Length of year (earth-days) | 87.97 | 224.7 | 365.26 | 686.98 |
| Average orbital speed | 29.76 mi. per sec. (47.89 km per sec.) | 21.77 per sec. (35.03 km per sec.) | 18.51 mi. per sec. (29.79 km per sec.) | 14.99 mi. per sec. (24.13 km per sec.) |
| Diameter at equator | 3,031 mi. (4,878 km) | 7,521 mi. (12,104 km) | 7,926 mi. (12,756 km) | 4,223 mi. (6,796 km) |
| Rotation period | 59 earth-days | 243 earth-days | 23 hrs. 56 min. | 24 hrs. 37 min. |
| Tilt of axis (degrees) | about 0 | 178 | 23.44 | 23.98 |
| Temperature | −279 to 801 °F (−173 to 427 °C) | 864 °F (462 °C) | −128.6 to 136 °F (−89.6 to 58 °C) | −225 to 63 °F (−143 to 170 °C) |
| Atmosphere: | | | | |
| Pressure at surface | 0.00000000003 lb. per sq. in. (0.000000000002 kg per cm²) | 1,323 lbs. per sq. in. (93 kg per cm²) | 14.7 lbs. per sq. in. (1.03 kg per cm²) | 0.1 lb. per sq. in. (0.007 kg per cm²) |
| Gases | Sodium, helium, hydrogen, oxygen | Carbon dioxide, nitrogen, water vapour, argon, carbon monoxide, neon, sulphur dioxide | Nitrogen, oxygen, carbon dioxide, water vapour | Carbon dioxide, nitrogen, argon, oxygen, carbon monoxide, neon, krypton, xenon, water vapour |
| Mass (Earth=1) | 0.056 | 0.815 | 1 | 0.107 |
| Density (g/cm³) | 5.42 | 5.25 | 5.52 | 3.94 |
| Gravity (Earth=1) | 0.386 | 0.879 | 1 | 0.38 |
| Number of known satellites | 0 | 0 | 1 | 2 |

*Many of these figures are approximations or obtained by scientific calculations.

amount of gas in the atmosphere. The earth's atmosphere has enough gas to produce a pressure of 1.03 kilograms per square centimetre. But the atmosphere of Mars contains so little gas that its surface pressure is only about $\frac{1}{150}$ as great as the earth's. The atmosphere of Venus has so much gas that its surface pressure is as much as 90 times as great as the pressure on the earth.

Astronomers can estimate the amount of gas in a planet's atmosphere by measuring how the temperature varies throughout the atmosphere. A much more accurate, but more difficult, method is to measure changes in radio waves sent through the planet's atmosphere by a passing spacecraft.

**Surface features** of a planet like the earth include mountains, valleys, lakes, rivers, flat areas, and craters. A terrestrial planet's surface is shaped partly by conditions on the planet itself and partly by collisions with meteoroids. The giant planets do not have surfaces that we can see either from the earth or from space. Jupiter, Saturn, Uranus, and Neptune are made up mostly of gases and ice. When we observe their discs, all we see is the top layer of their atmospheres. The atmosphere of a giant planet is very deep. Astronomers have calculated that at the very centre of the giant planets there is a rocky core about the size of the earth. The core may be surrounded by liquid hydrogen that is under such high pressure that it behaves like a metal and conducts immensely powerful electric currents.

## Studying the planets

People began studying the planets thousands of years ago. They kept records of how the five planets then known moved and how they changed in brightness. The motion of the planets was not well understood until the 1600's. Today, there are still many unanswered questions about conditions on the planets and the origin of the planets. See also **Exobiology**.

**Explaining the motion of the planets** brought about one of the most interesting disputes in the history of science. The dispute involved two important theories.

One theory of planetary motion was suggested about A.D. 150 by Ptolemy, a Greek astronomer. He believed

| Jupiter ♃ | Saturn ♄ | Uranus ♅ | Neptune ♆ | Pluto ♇ |
|---|---|---|---|---|
| 483,600,000 mi.<br>778,400,000 km) | 888,200,000 mi.<br>(1,429,400,000 km) | 1,786,400,000 mi.<br>(2,875,000,000 km) | 2,798,800,000 mi.<br>(4,504,300,000 km) | 3,666,200,000 mi.<br>(5,900,100,000 km) |
| 460,200,000 mi.<br>740,600,000 km) | 838,800,000 mi.<br>(1,349,900,000 km) | 1,702,100,000 mi.<br>(2,739,300,000 km) | 2,774,800,000 mi.<br>(4,465,600,000 km) | 2,749,600,000 mi.<br>(4,425,100,000 km) |
| 507,000,000 mi.<br>816,000,000 km) | 937,600,000 mi.<br>(1,508,900,000 km) | 1,870,800,000 mi.<br>(3,010,700,000 km) | 2,824,800,000 mi.<br>(4,546,100,000 km) | 4,582,700,000 mi.<br>(7,375,100,000 km) |
| 390,700,000 mi.<br>(628,760,000 km) | 762,700,000 mi.<br>(1,277,400,000 km) | 1,607,000,000 mi.<br>(2,587,000,000 km) | 2,680,000,000 mi.<br>(4,310,000,000 km) | 2,670,000,000 mi.<br>(4,290,000,000 km) |
| 4,332.7<br>8.12 mi. per sec.<br>3.06 km per sec.) | 10,759<br>5.99 mi. per sec.<br>(9.64 km per sec.) | 30,685<br>4.23 mi. per sec.<br>(6.81 km per sec.) | 60,190<br>3.37 mi. per sec.<br>(5.43 km per sec.) | 90,800<br>2.95 mi. per sec.<br>(4.74 km per sec.) |
| 88,846 mi.<br>142,984 km) | 74,898 mi.<br>(120,536 km) | 31,763 mi.<br>(51,118 km) | 30,800 mi.<br>(49,500 km) | 1,430 mi.<br>(2,300 km) |
| 9 hrs. 55 min.<br>3.08 | 10 hrs. 39 min.<br>26.73 | 17 hrs. 8 min.<br>97.92 | 16 hrs. 7 min.<br>28.80 | 6 earth-days<br>98.8 |
| −250 °F<br>157 °C) | −288 °F<br>(−178 °C) | −357 °F<br>(−216 °C) | −353 °F<br>(−214 °C) | −387 to −369 °F<br>(−233 to −223 °C) |
| No surface. | No surface | No surface | No surface | ? |
| Hydrogen, helium, methane, ammonia, ethane, acetylene, phosphine, water vapour, carbon monoxide | Hydrogen, helium, methane, ammonia, ethane, phosphine (?) | Hydrogen, helium, methane | Hydrogen, helium, methane, acetylene | Methane, nitrogen (?) |
| 317.892<br>1.33<br>2.53 | 95.184<br>0.69<br>1.07 | 14.54<br>1.27<br>0.91 | 17.15<br>1.64<br>1.14 | 0.002 (?)<br>2.03 (?)<br>0.07 (?) |
| 16 | 18 | 15 | 8 | 1 |

the earth was the centre of the universe. He thought the sun, moon, planets, and stars travelled around the earth, making one complete revolution in a day. Ptolemy's theory explained what people saw in the sky, and guided their thinking for over a thousand years.

The dispute began in 1543, when the Polish astronomer Nicolaus Copernicus suggested that the earth and the other planets travelled around the sun. He also suggested that the earth turned on an axis, making one complete rotation in a day. Copernicus' theory made it easier to describe the motions of the planets, and astronomers soon began to use it. But religious leaders called Copernicus a fool for saying that the earth was just another planet. They banned his writings till 1757.

Discoveries by other astronomers gradually convinced people that the Copernican theory was correct. One such discovery was that Mercury and Venus, unlike the other planets, show phases like the moon, as increasing or decreasing amounts of their discs are illuminated by the sun (see **Moon** [The phases of the moon]). The Italian astronomer Galileo Galilei made this discovery in 1610, using the newly invented telescope. Galileo realized that Mercury and Venus must be travelling around the sun and that Copernicus could be right about a sun-centred system. When he also discovered satellites travelling around Jupiter, he was convinced that Copernicus was right and that the earth was a planet travelling around the sun. Kepler's laws of planetary motion boosted Copernicus' theory even more. However, the Copernican theory gained widespread support only after the English scientist Sir Isaac Newton discovered the law of universal gravitation in about 1665. This law described the pull of the sun on the planets moving around it. See also **Astronomy** (History).

**Improved observations.** After the motions of the planets became understood, astronomers began detailed studies of the individual planets. With better telescopes that could reveal more detail, they measured the sizes, colours, and other characteristics of the planets. They also discovered the most distant planets— Uranus, Neptune, and Pluto. The discovery that planets send out radio waves, and the study of these waves, led to greater understanding of conditions on each planet.

Today, astronomers use a variety of telescopes on the ground and in space to learn about the planets. Astronomers also have been looking for planets outside the solar system. A planet as large as Jupiter would exert a weak gravitational pull on its parent star. Astronomers could detect the presence of such a planet around a nearby star by observing irregularities in the motion of the star produced by this gravitational tug.

Spacecraft and high-speed computers have contributed much to planetary observations. Unmanned probes have made close-up observations of all the planets except Pluto. Unmanned probes have landed on both Mars and Venus and sent back valuable data, including photographs from the planets' surfaces. Other probes have analysed the atmospheres and climates or weather of the planets. The U.S. spacecraft *Voyager 1* and *Voyager 2* confirmed the giant planets all have strong magnetic fields. (Mercury, Venus, and Mars do not.) They also showed that Saturn is not the only planet with a ring system—all the giant planets have rings. The *Voyager* probes also sent back images of the planets' satellites and discovered many previously unknown satellites. Scientists have used advanced computers to analyse the images and other data sent back to the earth by these spacecraft.

**Explaining the formation of the planets.** Most astronomers today believe that the sun, planets, and smaller bodies in the solar system formed from a large cloud of loosely packed gas and dust about 4.6 billion years ago. The gravitational pull of particles within the spinning cloud caused it to contract a great deal and become more dense. Most of the material was pulled toward its centre and formed the sun. Smaller amounts of material remained in orbit around the forming sun and became flattened into a thin *protoplanetary disc.*

The gas and dust in the protoplanetary disc could eventually have formed small chunks. Gentle collisions of these chunks then built up larger objects. As the objects grew, their gravity increased. The larger bodies could have pulled in dust, gas, and smaller objects and grown quickly. Astronomers believe that these large bodies became the planets and their moons.

This theory of the origin of the solar system also can account for general differences between the rocky, terrestrial planets and the giant planets, which consist mainly of gases and ice. Astronomers calculate that the protoplanetary disc of dust and gas was hotter near its centre than at its edge, which was far from the forming sun. In the hottest regions of the disc, only metals and other rocky materials could form chunks. The sun's heat prevented atoms of hydrogen, helium, and other light elements from becoming solids or liquids. These hot gases moved quickly and so could escape the gravity of the chunks of rock. In addition, some astronomers think that the *solar wind* (a stream of gases flowing from the sun) may have driven the light elements from the inner solar system. As a result, the inner, terrestrial planets are mostly rocky worlds.

The sun's heat and the solar wind had much less effect on the outer portions of the disc. Cooler temperatures allowed water vapour, ice, and such gases as hydrogen, helium, methane, and ammonia to remain. Astronomers think that the gases and icy material formed Jupiter, Saturn, Uranus, and Neptune. As these planets formed, they could have had orbiting discs of dust, gas, and ice—much like the sun's protoplanetary disc. These discs may have formed the ring and satellite systems around the giant planets.

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Solar system
Space travel
Sun
Telescope
Year
Zodiac

**Planetarium** is a device that shows the changing positions of the sun, moon, stars, and planets by projecting lights on the inside of a dome. A building with such a device is also called a planetarium. The building may stand alone or may be part of a museum, school, or university. The term *planetarium* can also mean a device that shows the motion of planets around the sun.

**Forms of planetariums.** A simple form of planetarium is called an *orrery.* It is named after the Earl of Orrery, an Irish nobleman for whom one of the first orreries was built in the early 1700's. In an orrery, a central ball represents the sun, and smaller balls on movable arms represent the planets and their satellites. Such machines give a fairly accurate demonstration of the relative motions of the planets of the solar system. But most orreries do not indicate the planets' relative sizes or their distances from the sun.

The most common kind of modern planetarium is a projector shaped somewhat like a dumbbell. It has a large ball called a *star ball* at each end. One star ball projects the image of the Northern Hemisphere of the sky, and the other projects that of the Southern Hemisphere. A lamp inside each star ball produces a bright light that shines either through tiny holes in the ball or through lenses on the surface of the ball. The light passes through the holes or lenses and hits a curved screen, where the beams of light appear as stars or other heavenly bodies. The lenses focus the light so that brighter stars appear as bright points of light on the screen rather than as large discs.

**Planetarium presentations.** The planetarium projector is often used in a large theatre. But it is often only a part of a presentation, which may include slides and other special effects. Devices housed in the walls of the theatre or on the projector produce most of these other effects. The stars, planets, and all the effects are projected onto a dome that can measure up to about 30 metres in diameter. A lecturer may control a presentation from a console near the edge of the theatre. Or a computer may run a recorded presentation. For example, a computer program might include special effects that look like a sunrise. The program would direct lights that brighten the ceiling and effects that show thin red clouds in the east and a slowly rising sun.

Today, most planetarium projectors can show how the night sky looks from any location on the earth or how it looked hundreds of years ago. A projector introduced in the 1980's uses computer graphics to show what it would be like to travel to distant star systems at speeds approaching that of light, and how the sky would appear when we got there.

**Planetesimal theory.** See **Earth** (How the earth began); **Moon** (The moon's surface).

**Planetoid.** See **Asteroid.**

**Plankton** is the mass of tiny organisms that drifts at or near the surface of oceans, lakes, and other bodies of water. The word *plankton* comes from a Greek word that means *wandering.* Some planktonic organisms can swim, but they cannot swim strongly enough to avoid being carried about by water currents.

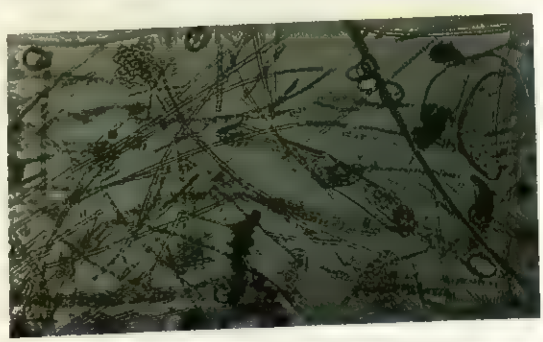
A wide variety of organisms make up plankton. Many cannot be seen without a microscope. Scientists often divide plankton into two main types—*phytoplankton* and *zooplankton*—based on the organisms it contains. Phytoplankton consists chiefly of simple, one-celled algae. Zooplankton includes microscopic protozoans and such sea animals as copepods, water fleas, and jellyfish.

**A planetarium projector** creates an image of the night sky on a dome. In this photograph, an audience in a planetarium sees how the earth and stars would look from the moon's surface.

Some organisms spend their entire life as plankton. They are called *holoplankton.* Other organisms, called *meroplankton,* spend only part of their life as plankton. The most common meroplanktonic organisms are the eggs and *larvae* (immature forms) of animals that live on the floors of shallow seas. These organisms drift freely as plankton until they develop into adults and settle to the bottom. Other meroplanktonic organisms include the eggs and larvae of larger, free-swimming animals, such as fish and squid.

Plankton plays an important part in *food chains* in bodies of water. Food chains are the feeding relationships between organisms. Phytoplankton forms the base of these food chains. Phytoplankton can grow using only sunlight and the minerals in water in a process called *photosynthesis.* Certain zooplankton eat phytoplankton. These zooplankton are in turn eaten by larger zooplankton, and by fish and other water animals. Food material produced by plankton also may sink and be consumed by bottom-dwelling organisms.

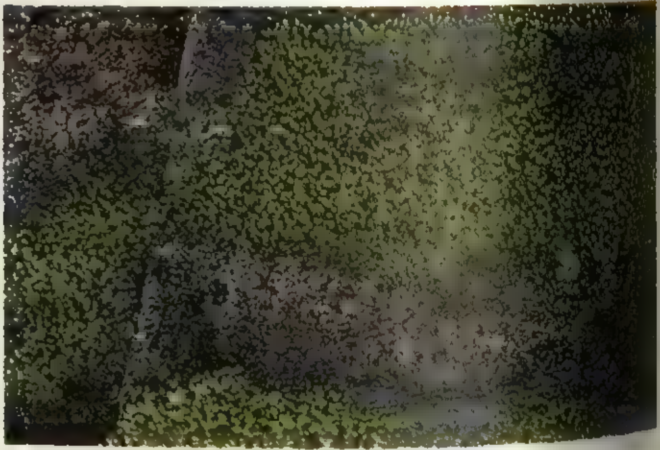
See also **Dinoflagellate; Gas** (How natural gas was formed); **Ocean** (The plankton; picture); **Red tide; Seashore.**



**Plankton is made up of many types of organisms.**

A towering sequoia

Kernels harvested from maize



Moss growing on a rock

**Plants vary greatly** in size and form, ranging from tall, majestic trees to tiny, simple mosses. More than 260,000 species of plants grow in all parts of the world. Plants supply people with food and many other useful products. They also add beauty and pleasure to people's lives.

# Plant

**Plant.** Plants grow in almost every part of the world. We see such plants as flowers, grass, and trees nearly every day. Plants also grow on mountaintops, in the oceans, and in many desert and polar regions.

Without plants, there could be no life on the earth. People could not live without air or food, and thus could not live without plants. The oxygen in the air we breathe comes from plants. The food that we eat comes from plants or from animals that eat plants. We build houses and make many useful products from timber. Much of our clothing is made from the fibres of the cotton plant.

Scientists believe there are more than 260,000 *species* (kinds) of plants, but no one knows for sure. Some tiny plants that grow on the forest floor can barely be seen. Others tower over people and animals. Among the largest living things on earth are the giant sequoia trees of California, U.S.A. Some stand more than 88 metres high and measure over 9 metres wide. Plants also are the oldest living things. One bristlecone pine tree in California started growing 4,000 to 5,000 years ago.

Many scientists divide all living things into five main groups called *kingdoms.* These kingdoms are (1) plants, (2) animals, (3) fungi, (4) protists, and (5) monerans. Scientists group organisms in a particular kingdom because the organisms share certain basic characteristics. These characteristics include physical structure, means of obtaining food, and means of reproduction.

Plants have a number of characteristics that set them apart from other living things. For example, both plants

A botanical garden displaying a variety of trees and colourful flowers

Landscaping in an office building

Collecting sap from a maple tree

and animals are complex organisms that are made up of many types of cells. However, plant cells have thick walls that consist of a material called *cellulose.* Animal cells do not have this material. The cells of monerans and some protists, like those of plants, have cellulose walls. But monerans and protists are simple organisms made up of one cell or only a few types of cells. Bacteria, including blue-green algae, are monerans. Protists include other algae and diatoms and protozoans.

All plants develop from a tiny form of the plant called an *embryo.* Monerans, protists, and fungi—such as moulds and mushrooms—do not develop from embryos. Plants also obtain food in ways different from those of most other organisms. Almost all plants stay in one place for their entire lives. Most plants make their own food from air, sunlight, and water by a process called *photosynthesis.* Some plants such as broomrape and dodder, are not green and do not produce their food by photosynthesis. They are *parasites* that obtain their food from other plants. Some other plants, such as Indian pipe and the coralroot orchid, are *saprophytes.* They feed on dead plant or animal matter. Fungi cannot make their own food. They obtain the nutrients they need from the animals, plants, and decaying matter on which they live. Animals also cannot make their own food, but most animals can move about to find it.

This article provides general information on the plant kingdom. It tells why plants are important to people and describes the major groups of plants and where and how they live. It includes a classification table of the plant kingdom. See the *Related articles* at the end of this article for a list of articles on many kinds of plants.

## The importance of plants

Plants supply people with food, clothing, and shelter. Many of our most useful medicines are made from plants. In addition, plants add beauty and pleasure to our lives. Most people enjoy the smell of flowers, the sight of a field of waving corn, and the quiet within a forest.

Not all plants are helpful to people. Some species grow in fields and gardens as weeds that choke off useful plants. Tiny bits of pollen from certain plants cause such health problems as asthma and hay fever. Some plants are poisonous if eaten. Others, such as nettles and poison ivy, irritate the skin.

**Food.** Plants are probably most important to people as food. Sometimes we eat plants themselves, as when we eat apples, peas, or potatoes. But even when we eat meat or drink milk, we are using foods that come from an animal that eats plants.

People get food from many kinds of plants—or parts of plants. The seeds of such plants as maize, rice, and wheat are the chief source of food in most parts of the world. We eat bread and many other products made from these grains, and almost all our meat comes from animals that eat them. When we eat beetroot, carrots, or sweet potatoes, we are eating the roots of plants. We eat the leaves of cabbage, lettuce, and spinach plants; the stems of asparagus and celery plants; and the flower buds of broccoli and cauliflower plants. The fruit of many plants also provide us with food. They include apples, bananas, berries, and oranges, as well as some nuts and vegetables. Coffee, tea, and many soft drinks get their flavour from plants.

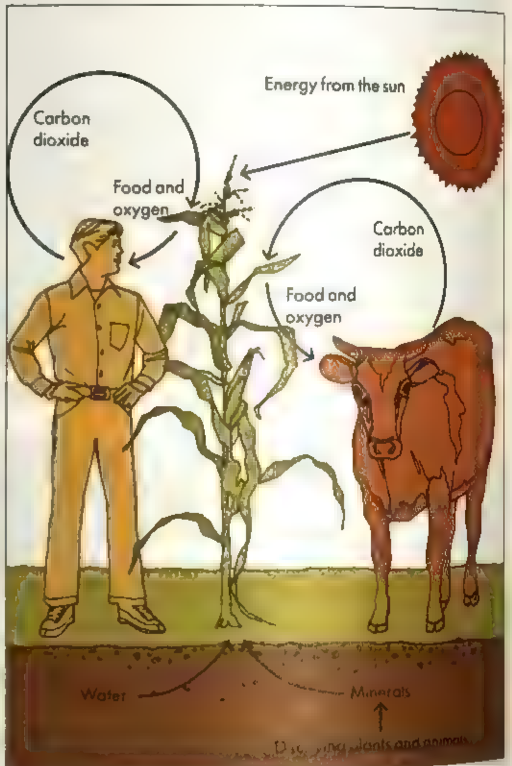
**Raw materials.** Plants supply people with many important raw materials. Trees give us timber for building homes and making furniture and other goods. Wood chips are used in manufacturing paper and paper products. Other products made from trees include cork, natural rubber, maple syrup, and turpentine. Most of the world's people wear clothing made from cotton. Threads of cotton are also woven into carpets and other goods. Rope and twine are made from hemp, jute, and sisal plants.

Plants also provide an important source of fuel. In many parts of the world, people burn wood to heat their homes or to cook their food. Other important sources of fuel—coal, oil, and natural gas—also come from plants. Coal began to form millions of years ago, when great forests and swamps covered much of the earth. As the trees in these forests died, they fell into the swamps, which were then covered by mud and sand. The increasing pressure of this mass of materials helped cause the dead plants to turn into coal. Petroleum and natural gas were formed in ancient seas by the pressure of mud, sand, and water on decaying masses of plants and animals.

**Medicines.** Many useful drugs come from plants. Some of these plants have been used as medicines for hundreds of years. More than 400 years ago, for example, some Indian tribes of South America used the bark of the cinchona tree to reduce fever. The bark is still used to make *quinine,* a drug used to treat malaria and other diseases. Another drug, called *digitalis,* is used in treating heart disease. It is made from the dried leaves of the purple foxglove plant. The roots of the Mexican yam are used in producing *cortisone,* a drug useful in treating arthritis and a number of other diseases.

**Plants and the cycle of nature**

Plants play an important part in the cycle of nature. They grow by taking energy from the sun, carbon dioxide from the air, and water and minerals from the ground. During the cycle, plants supply us with food and give off the oxygen that we breathe.




**Plants and the cycle of nature.** All living things—plants, animals, fungi, protists, and monerans—are linked by the *cycle of nature.* This natural process gives people oxygen to breathe, food to eat, and heat to keep them warm. The sun supplies the energy that runs the cycle.

Plants have a complex relationship with people and animals in the cycle of nature. Plants use sunlight to make their own food, and they give off oxygen during the process. People and animals eat the plants and breathe in the oxygen. In turn, people and animals breathe out carbon dioxide. Plants combine the carbon dioxide with energy from sunlight and water and minerals from the soil to make more food. After plants and animals die, they begin to decay. The rotting process returns minerals to the soil, where plants can again use them.

Plants also play an important part in *conservation,* the protection of soil, water, wildlife, and other natural resources. Plants help keep the soil from being blown away by the wind or washed away by water. They slow down the flow of water by storing it in their roots, stems, and leaves. Plants also give wild animals food to eat and a safe place to live. For more information on the importance of plants in nature, see the *World Book* articles on **Balance of nature, Conservation,** and **Ecology.**

Each of the more than 260,000 species of plants differs from every other species in one or more ways. However, plants also have many features in common. Based on these similarities, scientists are able to classify distinct plants into groups. The study of plants is called *botany*, and scientists who study plants are known as *botanists*.

This section describes the chief kinds of plants found in the plant kingdom. It is divided into five basic groups: (1) seed plants, (2) ferns, (3) lycophytes, (4) horsetails, and (5) bryophytes. A table showing a more detailed system of plant classification that is used by many botanists appears at the end of the article. See also **Classification, Scientific**.

**Seed plants** consist of a wide variety of plants that bear seeds to reproduce. Most botanists divide the seed plants into two main groups of plants—*angiosperms* and *gymnosperms*.

*Angiosperms* are flowering plants. They make up almost 90 per cent of the more than 260,000 kinds of plants. They produce seeds that are enclosed in a protective seed case. The word *angiosperm* comes from two Greek words meaning *enclosed* and *seed*. All plants that produce flowers and fruit are angiosperms. They include most of our common plants, such as brightly coloured garden plants, many kinds of wild flowers, and most trees, shrubs, and herbs. Most of the plants that produce the fruit, grains, and vegetables that people eat also are angiosperms. See **Angiosperm**.

The size of angiosperms varies greatly. The smallest flowering plant, the duckweed, is only about 0.5 millimetre long. It floats on the surface of ponds. The largest angiosperms are eucalyptus trees. They grow more than 90 metres tall.

Some botanists divide the angiosperms into two smaller groups. Plants in one group, called *monocotyledons* or *monocots*, grow from seeds that contain a seed leaf called a *cotyledon* (see **Cotyledon**). Plants in the other group, called *dicotyledons* or *dicots*, have two cotyledons in their seeds.

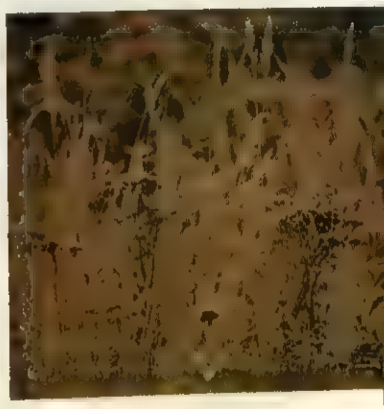
*Gymnosperms* include a wide variety of trees and shrubs that produce naked or uncovered seeds. Most gymnosperms bear their seeds in cones. The word *gymnosperm* comes from two Greek words meaning *naked* and *seed*. Gymnosperms do not produce flowers. This group is made up of such plants as conifers, cycads, ginkgoes, and gnetophytes. See **Gymnosperm**.

Conifers are the best known of the gymnosperms. They include such trees as cedars, cypresses, firs, pines, redwoods, and spruces. Most conifers have needlelike

**Angiosperms** Any plant that produces flowers and fruit is considered an angiosperm. More than half of all the many kinds of plants belong to this group.


Cherry tree


Wood anemone


Grasses


Cotton—buds, flowers, and bolls


Tomato—flowers and young fruit


Prickly pear cactus

or scalelike leaves. Their seeds grow on the upper side of the scales that make up their cones. The cones of some conifers, such as junipers, look like berries. Most conifers are *evergreens*—that is, they shed old leaves and grow new leaves continuously and so stay green throughout the year. Wood from conifers is widely used in construction and papermaking. Conifers also provide animals with food and shelter. See **Conifer.**

Cycads and ginkgoes have lived on the earth for millions of years. Large numbers of these plants once grew over wide regions of land. Most cycads look much like palm trees. They have a branchless trunk topped by a crown of long leaves. But unlike palm trees, they bear their seeds in large cones. Only one kind of ginkgo survives today. It is an ornamental tree with flat, fan-shaped leaves. It bears seeds at the ends of its branches. See **Cycad; Ginkgo.**

Gnetophytes are an unusual group of gymnosperms. These plants have many features that resemble those of flowering plants. For example, the *Gnetum* has broad, oval-shaped leaves and special water-transport tubes, much like those of angiosperms. The cones of all gnetophytes are flowerlike in many details.

**Ferns** grow chiefly in moist, wooded regions. They differ greatly in size and form. Some aquatic ferns have leaves only about 2.5 centimetres long. But in the tropics, tree ferns may grow more than 20 metres high.

Fern leaves, called *fronds,* are made up of many tiny leaflets and may be quite large. On most types of ferns, the fronds are the only parts that grow above the ground. They grow from underground stems that may run horizontally under the surface of the ground. When the fronds first appear, they are tightly coiled. The fronds unwind as they grow.

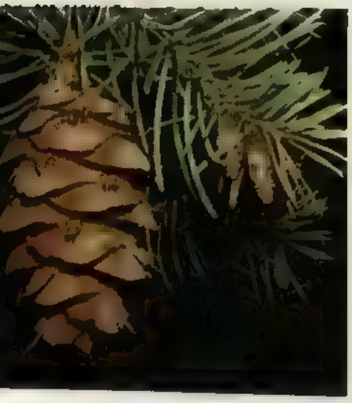
Ferns are among the oldest kinds of plants that live on land. During prehistoric times, great numbers of large ferns covered the earth. These ferns, along with giant club mosses and horsetails, accounted for much of the plant life that later formed coal. See **Fern.**

**Lycophytes** include club mosses, quillworts, and selaginellas. These plants have leaves with a single, central vein. Lycophytes were among the first plants to grow on land.

Club mosses have tiny needlelike or scalelike leaves that usually grow in a spiral pattern. They are not true mosses. Club mosses are found from tropical to temperate regions. They often form a "carpet" on the forest floor. See **Club moss.**

Quillworts are found chiefly in moist soils around lakes and streams. They have short stems and long,

**Gymnosperms** Most of the trees and shrubs that make up this group bear their seeds in cones and have needlelike or scalelike leaves. Some have cones that look like berries.



**Douglas fir**

**Engelmann spruce**

**Cycad**

**Umbrella pine**

**Japanese yew**

**Ginkgo**

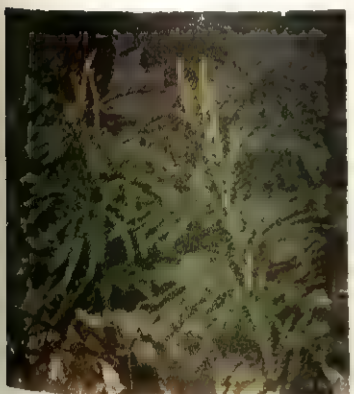
**Ferns and horsetails** These plants grow chiefly in moist, wooded areas. Fern leaves, called *fronds,* consist of many small leaflets and may be quite large. Horsetails have tiny leaves and hollow, jointed stems.

Fern

Tree fern

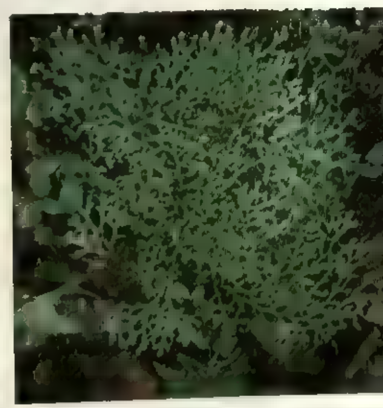
Horsetail

**Lycophytes** These plants include club mosses, quillworts, and selaginellas. Club mosses have tiny needlelike or scalelike leaves. Quillwort leaves are long and quill-like. Selaginellas have small, thin leaves.



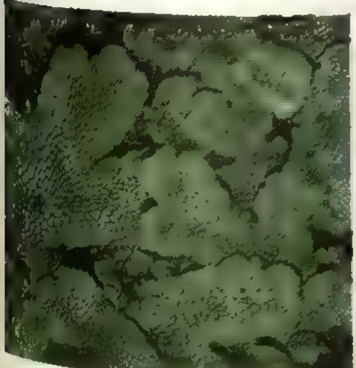
Ground pine club moss

Quillwort



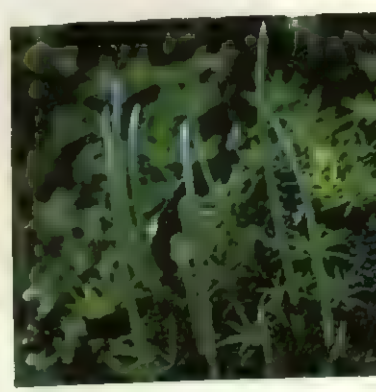
Selaginella

**Bryophytes** Liverworts, mosses and hornworts make up this group. These small plants grow in most parts of the world. They thrive in moist, shady places, such as ravines and forests.



Liverwort

Sphagnum moss



Hornwort

quill-like leaves. The leaves usually grow to about 35 centimetres long. Ancient plants related to quillworts were large trees that grew up to about 40 metres tall. Scientists believe that these plants lived about 290 million years ago.

There are about 700 kinds of selaginellas. These plants are usually found in tropical and subtropical regions. They often grow in damp places on the forest floor. Selaginellas have small, thin leaves. Their stems may grow either upright or along the ground. These plants first appeared on earth over 300 million years ago.

**Horsetails** are an unusual group of small plants that have hollow, jointed stems. Horsetails grow about 60 to 90 centimetres tall. The plants have green stems and tiny, black leaves. The stems capture the sunlight used by the plant to make food in photosynthesis. In some horsetails, the branches grow in *whorls* (circles) around the main stem of the plant, and the plant resembles a horse's tail. Tiny amounts of minerals are concentrated in the stems of horsetails, including gold and silica. Silica makes the stems very coarse, like sandpaper. Some kinds of horsetails are called *scouring rush* because people once used these plants to scour their pots and pans. See **Horsetail**.

**Bryophytes** are a group of plants made up of liverworts, mosses, and hornworts. These plants live in almost all parts of the world, from the Arctic to tropical forests. They grow in such moist, shady places as forests and ravines. Bryophytes are the only types of plants that lack *vascular tissue*—that is, tissue that carries water and food throughout the plant.

Most liverworts, mosses, and hornworts measure less than 20 centimetres tall. None of these plants have true roots. Instead, they have hairy rootlike growths called *rhizoids* that anchor the plants to the soil and absorb water and minerals.

Peat moss, a substance made up of thick growths of *Sphagnum* and other mosses, is often used in gardening. Gardeners mix peat moss into the soil to keep the soil loose and to help it hold moisture. See **Hornwort**; **Liverwort**; **Moss**.

## *Where plants live*

Most species of plants live in places that have warm temperatures at least part of the year, plentiful rainfall, and rich soil. But plants can live under extreme conditions. Mosses have been found in Antarctic areas, where the temperature seldom rises above 0° C. Many desert plants grow in areas where the temperature may rise above 40° C.

Not all kinds of plants grow in all parts of the world. For example, cattails live only in such damp places as swamps and marshes. Cactuses, on the other hand, are found chiefly in deserts. Through long periods of time, many small changes have taken place in various kinds of plants. These changes enabled the plants to survive in a particular environment. For details of these changes, see the section of this article *How plants change*.

Many elements make up a plant's environment. One of the most important is the weather—sunlight, temperature, and *precipitation* (rain, melted snow, and other moisture). The environment of a plant also includes the soil and the other plants and the animals that live in the same area. All these elements form what scientists call a *natural community*.

No two natural communities are exactly alike, but many resemble one another more than they differ. Botanists divide the world into *biomes*—natural communities of plants, animals, and other organisms. Important land biomes include (1) the tundra, (2) forests, (3) scrub, (4) grasslands, (5) savannas, and (6) deserts. Forests are often subdivided into smaller biomes, such as temperate deciduous forests and tropical rainforests. In addition, many plants live in *aquatic* (water) regions that are not grouped as a specific biome. See **Biome**.

Human beings have greatly affected the natural communities. In North America, for example, great forests once extended from the Atlantic Ocean to the Mississippi River. Most of the trees were cleared by advancing settlers, and the forests have been replaced by cities and farms. The Mediterranean lands were once clothed with evergreen oak forests. Most have long since gone, as they have been cut down for timber. The forests have not been able to regenerate, owing to overgrazing by sheep and goats. In other parts of the world, irrigation and the use of fertilizers have enabled plants to be grown on once-barren land.

This section describes the natural plant life in the important land biomes and in aquatic regions. For information on where animals live, see the **Animal** article. For a discussion of the relationship between living things and their environment, see **Ecology**.

**The tundra** is a cold, treeless area that surrounds the Arctic Ocean, near the North Pole. It extends across the uppermost parts of North America, Europe, and Asia. The land in these regions is frozen most of the year, and the annual precipitation measures only from 15 to 25 centimetres. The upper slopes of the world's highest mountains—the Alps, the Andes, the Himalaya, and the Rockies—have conditions similar to those in the tundra.

Summers in the tundra last only about 60 days, and summer temperatures average only about 7° C. The top 30 centimetres or so of the land thaws during the summer, leaving many marshes, ponds, and swamps. Such plants as mosses, shrubs, and wild flowers grow in the tundra. These plants grow in low clumps and so are protected from the wind and cold. A thick growth of *lichens* (organisms made up of algae and fungi) covers much of the land. See **Tundra**.

**Forests** cover almost a third of the earth's land area. They consist chiefly of trees, but many other kinds of plants also grow in forests. Some botanists divide the many types of forests into three major groups: (1) coniferous forests, (2) temperate deciduous forests, and (3) tropical rainforests.

***Coniferous forests*** are made up mainly of trees that are *coniferous* (cone-bearing) and evergreen. Most ecologists distinguish between *boreal forests*, also called *taiga*, and *temperate coniferous forests*.

Boreal forests grow in regions that have a short summer and a long, cold winter. The growing season in

**Major plant regions of the world**

Plants live everywhere except in regions that have permanent ice. But not all plants grow in all regions of the world. This map shows the five major regions in which certain kinds of plants grow best. For example, cactuses grow chiefly in deserts, and cattails in *aquatic* (watery) regions.

Tundra and high mountain

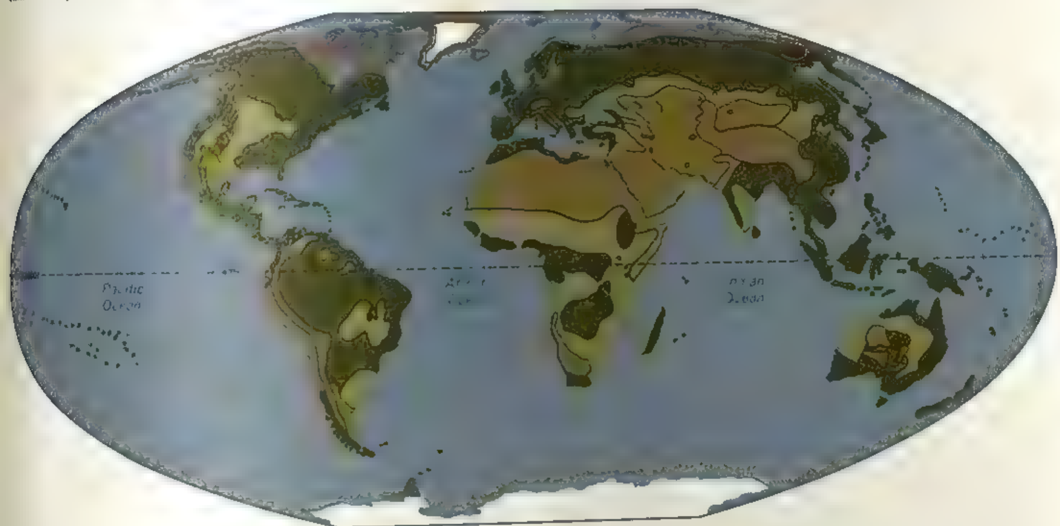
Forest

Grassland

Desert

Aquatic area

Permanent ice



these regions may last less than three months. Boreal forests are found in the northernmost parts of North America, Europe, and Asia. They also grow in the high mountains of these continents. Trees found in boreal forests include such evergreen conifers as firs, larches, spruces, and pines. The pointy, triangular shape of these trees helps them shed heavy snow.

Only a few types of plants such as mosses and some shrubs grow on the floor of boreal forests. Thick layers of old needles build up beneath the trees. These needles contain acids that are slowly released as the needles decay. Water carries the acids into the soil. The acidic water dissolves many minerals and carries them into the deeper layers of the soil. As a result, the topsoil found in boreal forests is often very sandy and unable to support many types of small plants.

Temperate coniferous forests grow in western North America in areas that have mild, wet winters and dry summers. The redwood forests of northern California and the temperate rainforests found on the Olympic Peninsula of Washington state are both examples of temperate coniferous forests. Major trees of the temperate coniferous forest include redwoods and giant sequoias in the south and Douglas fir, hemlocks, cedars, and pines in more northern areas.

***Temperate deciduous forests*** cover large areas of North America, central Europe, east Asia, and Australia. In the United States, temperate deciduous forests grow mostly east of the Mississippi River and extend northward into southern Canada, where they become mixed with coniferous forests. Most of these areas have cold winters and warm, wet summers.

Most of the trees in temperate deciduous forests are called *broadleaf trees* because they have broad, flat leaves. They also are *deciduous*—that is, they lose their leaves every autumn and grow new ones in the spring. Trees that grow in temperate deciduous forests include ashes, beeches, birches, chestnuts, hazels, hickories, maples, oaks, poplars, and walnuts. A thick growth of wild flowers, seedlings, and shrubs covers the floor of most of these forests.

***Tropical rainforests*** grow in regions that have warm, wet weather all year round. These regions include Central America and the northern parts of South America, central and western Africa, Southeast Asia, New Guinea, the Pacific Islands, and the very north of Australia.

Most trees in tropical rainforests are broadleaf trees. Because of the warm, wet weather, they never completely lose their leaves. These trees lose a few leaves at a time throughout the year. Many kinds of trees grow in tropical rainforests, including mahoganies and teaks. The trees grow so close together that little sunlight can reach the ground. As a result, only ferns and other plants that require little sunlight can grow on the forest floor. Many plants, including lichens, orchids, and vines, grow high on the trees.

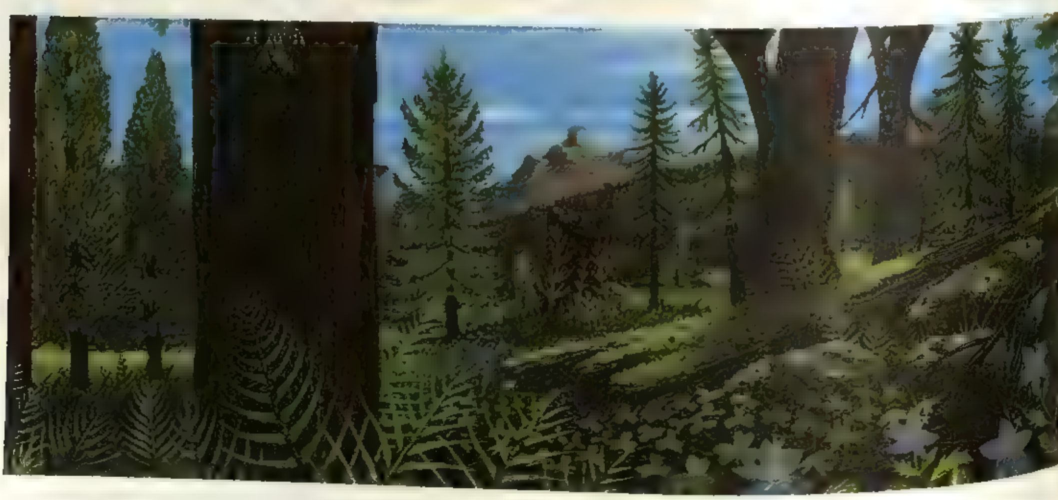
The heavy rainfall that occurs in tropical rainforests dissolves much of the nutrients and organic materials out of the soil. As a result, the soils found in tropical rainforests contain a very small amount of nutrients and organic matter. However, the soil is able to support the lush growth found in these forests because fresh nutrients from the decay of fallen leaves are continually being released into the soil.

**Grasslands** are open areas where grasses are the most plentiful plants. These areas account for over 25 per cent of the earth's natural vegetation. In the United States and Canada, most of the natural grasslands are used to grow crops. There, farmers and ranchers grow such grains as barley, oats, and wheat where bluestem, buffalo, and grama grasses once covered the land.

Botanists divide grasslands into *steppes* and *prairies.*

## Plants of the high mountains

Plants of the high mountains are similar to those of the northern tundra. As a protection against the cold and wind, most plants are low growing, and take the form of cushions or rosettes. Plants with cushionlike growth usually have a particularly long root to anchor them to the ground and store water. Heat absorbed during the day is trapped inside the closely matted foliage and retained during the night. Conifers adapted to growing at high altitude include alpine firs, pines, and junipers. Azaleas are high-altitude shrubs of the Himalaya.



## Plants of the coniferous forest

Coniferous (needleleaf) forests extend as a broad belt across the Northern Hemisphere and along northern Pacific coastal regions, and are to be found on mountainsides. Coniferous forests are made up of relatively few types of coniferous trees, such as firs, hemlocks, pines, and spruces. These trees retain their leaves all year round. Conifers are hardy plants that can withstand severe frosts, waterlogged soil, and thick snow cover. Plants of the floor of coniferous forests include ferns, horsetails, lichens, mosses, and shrubs such as bilberry and cranberry.

Only short grasses grow on steppes. These dry areas include the Great Plains of the United States and Canada, the *veld* of South Africa, and the Steppes of Kazakhstan and southern Russia. Taller grasses grow on the prairies of the American Midwest, eastern Argentina, and parts of Europe and Asia. Rolling hills, clumps of trees, and rivers and streams break up these areas. Most of the soil is rich and rainfall is plentiful. As a result, this type of grassland is used almost entirely to raise food crops and livestock. See **Grassland; Steppe.**

**Savannas** are grasslands with widely spaced trees. Some savannas are found in regions that receive little rain. Others are found in tropical regions, such as the Llamos of Venezuela, the Campos of southern Brazil, and the Sudan of Africa. Most of these areas have dry winters and wet summers. Grasses grow tall and stiff under such conditions. Acacia, baobab, and palm trees grow on many savannas. A wide variety of animals, such as antelope, giraffes, lions, and zebras, roam the savannas of Africa. See **Savanna.**

**Scrub** consists mainly of small evergreen shrubs with leathery, often *aromatic* (sweet smelling), leaves. This type of vegetation is found in coastal areas with hot, dry summers and mild, wet winters. It is common around the Mediterranean region, and is often known as Mediterranean vegetation. Other extensive areas of coastal scrub occur in southern and western Australia, South Africa, and in California, U.S.A.—where they are called *chaparral.*

During the dry summer season, fires are common in areas of scrub. But these fires actually help maintain the plant life. Many of the plants that grow in areas of scrub are either resistant to fire or are able to grow back quickly after they burn. The fires clear the dense vegetation away and expose bare ground to allow for new growth. The heat of the fires also stimulates development in the seeds of some plants. In addition, many types of short-lived, small flowers appear only after a fire has taken place. See **Chaparral; Heath.**

**Deserts** cover about a fifth of the earth's land. A huge desert region extends across northern Africa and into central Asia. This region includes three of the world's great deserts—the Arabian, the Gobi, and the Sahara. Other major desert regions of the world include the Atacama Desert along the western coast of South America, the Kalahari Desert in southern Africa, the Western Plateau of Australia, and the southwest corner of North America.

Some deserts have almost no plant life at all. Parts of the Gobi and the Sahara, for example, consist chiefly of shifting sand dunes. All deserts receive little rain and have either rocky or sandy soil. The temperature in most deserts rises above 38° C for at least part of the year. Some deserts also have cold periods. But in spite of these harsh conditions, many plants live in desert regions. These plants—sometimes called *xerophytes*—include cactuses, creosote bushes, Joshua trees, palm trees, sagebrush, and yuccas. Wild flowers are also found in the desert. See **Flower** (Flowers of the desert [with pictures]).

Desert plants do not grow close together. By being spread out, each plant can get water and minerals from a large area. The roots of most desert plants extend over large areas of land, and they capture as much rain

**Plants of the tropical rainforest**

Mature tropical forests cover about 7 per cent of the earth's surface and contain about 155,000 of the more than 350,000 known species of plants. The branches and leaves of the trees in a tropical forest are arranged in several storeys or *strata.* The tallest trees may be 60 metres high. Many of the trees have straight trunks. Others have stiltlike *prop roots* (roots that grow from the trunk above ground and help support the tree). Most trees of tropical forests are evergreen and have thick, leathery leaves. Woody vines called lianas and other climbing plants are common. *Epiphytes* (plants that grow on other plants) are also a feature of tropical forests.

**Plants of the deciduous forest**

Broadleaf trees are the main plants of the deciduous forest. The largest areas of deciduous forest are in the Northern Hemisphere. Oak trees are usually the dominant species. Beeches are the main trees of Southern Hemisphere deciduous forests. Small trees and shrubs, such as dogwood and hazel, and climbing plants, such as honeysuckle, are common plants of the shrub layer of a northern deciduous forest. In the spring, before the trees come into leaf and cast dense shade, the forest floor has many wild flowers, such as wood anemones and primroses.

**Plants of grasslands**

Grass-covered plains account for over 25 per cent of the earth's natural vegetation. Grasses and sedges are the main types of plants. They have various adaptations for surviving dry, windswept conditions. For example, a downy layer of hairs covers the leaves of many plants. The hairs hold a moisture-laden layer of air near the plant and so prevent water loss. The root system of grasses covers a large area to trap surface water and is also deep rooted to reach underground water supplies. Open grasslands are subject to violent storms. Lightning periodically burns large areas of grassland. Much of the world's grassland has been replaced by agricultural land for growing cultivated grasses such as oats and wheat.

**Plants of scrub**

Thick growths of shrubs and small trees flourish in areas with hot, dry summers and cool, wet winters. Plants of scrub areas are usually evergreen, with leaves that are thick and leathery or glossy and wax-coated—all adaptations to reduce evaporation of water from the leaf surface. Fires frequently occur during the summer and help stimulate new plant growth. Some plant seeds, such as those of Australian banksias, sprout when exposed to intense heat. When rain returns, shrubs grow new shoots from their old roots.

**Plants of the desert**

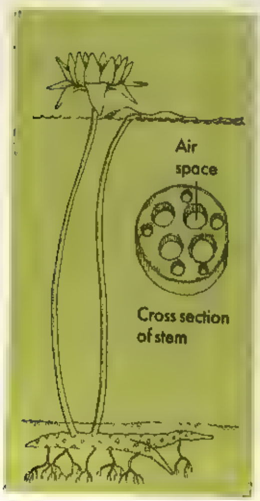
Cactus deserts are native only to the Southwestern United States, Central, and South America. The body of the cactus is its stem. Like the leaves of other plants, the stems of cactuses are the main food-manufacturing organs. They also store food and water. The stem of a cactus comes in many forms, from the flattened discs of the prickly pear cactus to the giant branching candelabra of the saguaro cactus. The actual cactus leaves are reduced to spines. *Euphorbias* are similar spiny plants of Africa. In the cold Gobi desert of Asia, the plants include saxaul trees, tamarisk, and salt bush. Typical Australian desert plants include spiny leaved spinifex grasses, desert peas, mulla mulla, and the marble gum tree. After rain, many desert plants can sprout, flower and produce seeds.

**Plants of a freshwater pond**

In the Northern Hemisphere, the margins of many ponds and lakes are fringed with trees such as alders and willows. Toward the water, false bulrushes or cattails form extensive beds. They are easily recognizable by their strap-shaped leaves and large chocolate-brown flower heads. During the summer, many plants with roots in the pond bed grow upwards to flower on or above the surface. One of these plants, the bladderwort, has a short white flower spike held above the surface. Among its finely divided leaves, below the surface, are small air-filled bladders. The bladders trap small organisms, which are digested by the plant.

**Special features of freshwater plants**

Plants that live in ponds have special features that enable them to survive. The features of two kinds of these plants, the white water lily and a water milfoil, are shown below.




The air spaces in the stem of the white water lily serve two purposes. They help hold the plant upright in the water, and they carry air down through the stem to the roots.

The long, underwater leaves of the water milfoil are especially suited to absorb carbon dioxide from the water. The leaves that grow above water resemble those of land plants.

water as possible. Cactuses and other *succulent* (juicy) plants store water in their thick leaves and stems. See **Cactus; Desert.**

**Aquatic regions** are bodies of fresh or salt water. Freshwater areas include lakes, rivers, swamps, and marshes. Coastal marshes and seas are saltwater regions. Most aquatic plants, which are also called *hydrophytes,* live in places that receive sunlight. These plants grow near the water surface, in shallow water, or along the shore.

Some kinds of aquatic plants, including eelgrass, live completely under the surface of the water. Other species of aquatic plants, such as duckweed, the smallest known flowering plant, float freely on the surface. Still others, such as the water marigold, grow only partly underwater. Many aquatic plants have air spaces in their stems and leaves. The air spaces help them stand erect or stay afloat.

Aquatic regions have unique conditions that make it difficult for many types of plants to grow there. For example, swamps and marshes, as well as flood plains along many streams and rivers, become flooded leaving the plants that live in these areas completely covered by water. As a result, only a few species of plants are able to survive in aquatic regions. Common freshwater plants include duckweeds, pondweeds, water lilies, sedges, and cattails. Such trees as bald cypresses, blackgums, and willows also grow in fresh water. Saltwater plants include eelgrass, cordgrass, and many types of sedges. See **Water plant.**

All plants—like all living things—are made up of cells. In plants, there are many kinds of cells that have special jobs, and together these cells form the various parts of the plant. A giant redwood tree, for example, has many billions of cells. See **Cell**.

A group of cells that are organized to perform a particular function is called a *tissue.* Plants are made up of many types of complex tissues. All plants, except bryophytes—that is, mosses, liverworts, and hornworts—have conducting tissue that carries water, minerals, and other nutrients throughout the plant body. This tissue is called *vascular tissue.* It is made up of two specialized tissues called *xylem* and *phloem.* The xylem tissue consists of cells that carry water and minerals from the roots to the leaves. The phloem tissue is made up of cells that carry food made by photosynthesis in the leaves to the other parts of the plant. Plants that have these special tissues are called *vascular plants.* Bryophytes are called *nonvascular plants* because they lack xylem and phloem.

A plant is made up of several important parts. Flowering plants, the most common type of plants, have four main parts: (1) roots, (2) stems, (3) leaves, and (4) flowers. The roots, stems, and leaves are called the *vegetative* parts of a plant. The flowers, fruit, and seeds are known as the *reproductive* parts.

**Roots.** Most roots grow underground. As the roots of a young plant spread, they absorb the water and minerals that the plant needs to grow. The roots also anchor the plant in the soil. In addition, the roots of some plants store food for the rest of the plant to use. Plants with storage-type roots include beets, carrots, radishes, and sweet potatoes.

There are two main kinds of root systems—*fibrous* and *taproot.* Grass is an example of a plant with a fibrous root system. It has many slender roots of about the same size that spread out in all directions. A plant with a taproot system has one root that is larger than the rest. Carrots and radishes have taproots. Taproots grow straight down, some to a depth of over 4.5 metres.

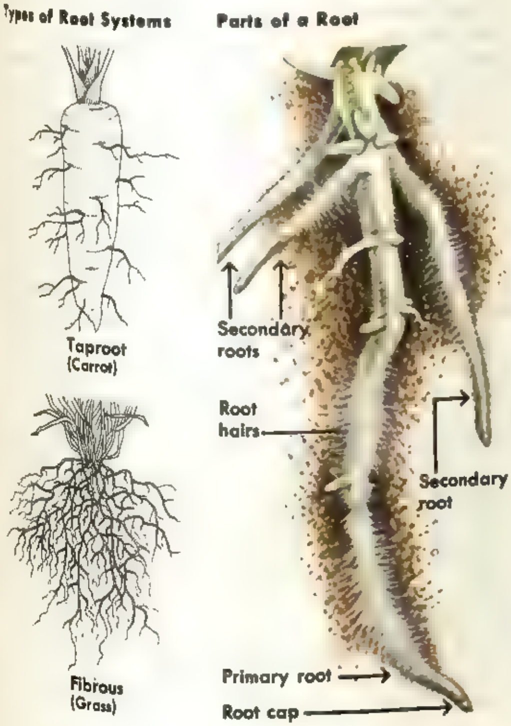
The root is one of the first parts of a plant that starts to grow. A *primary root* develops from a plant's seed and quickly produces branches called *secondary roots.* At the tip of each root is a *root cap* that protects the delicate tip as it pushes through the soil. Threadlike *root hairs* grow farther back on the root of the plant. Few of these structures are over 12 millimetres long. But there are so many of them that they greatly increase the plant's ability to absorb water and minerals from the soil.

The roots of some aquatic plants float freely in the water. Other plants, such as orchids and some vines, have roots that attach themselves to tree branches.

The roots of almost all land plants have a special relationship with fungi. In this relationship, known as *mycorrhiza,* fungi cover or penetrate the growing tips of a plant's roots. Water and nutrients enter the roots through the fungi. Fungi extend the plant's root system and improve the plant's ability to absorb water and min-

**Roots**

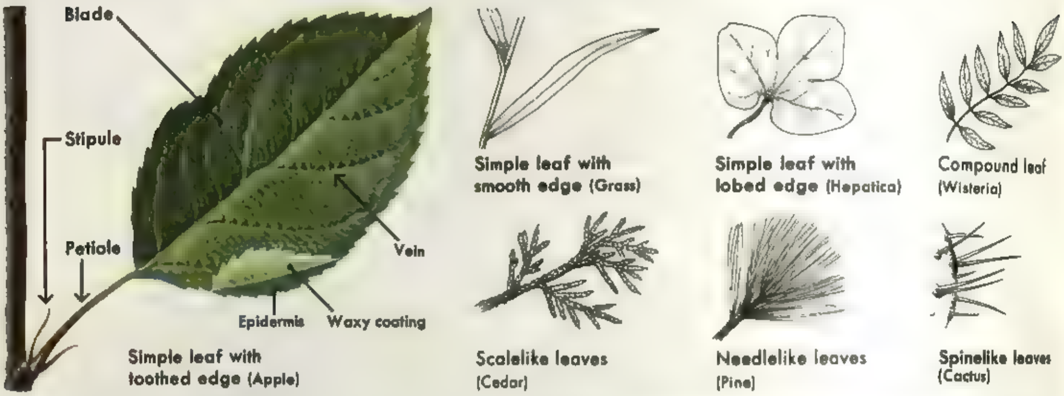
Most roots anchor a plant and absorb water and minerals. Plants have either a fibrous root system or a taproot system, *below left.* The main parts of a root are shown below on the right.




**Stems**

Most stems support the plant's flowers and leaves. Stems are *woody* or *herbaceous.* A woody stem, *left,* has a rough, brown surface. A herbaceous stem, *right,* has a smooth, green surface.

**Leaves** The leaves of most plants make food for growth and repair. The drawing on the left below shows the main parts of a leaf. The other illustrations show the wide variety of leaf types and shapes. In addition to simple and compound leaves, they include scalelike, needlelike, and spinelike leaves.




erals. Many botanists believe the first land plants developed millions of years ago from algae that lived in water. They think mycorrhizal relationships may have helped these plants to grow on land. See **Root**.

**Stems** of plants differ greatly among various species. They make up the largest parts of some kinds of plants. For example, the trunk, branches, and twigs of trees are all stems. Other plants, such as cabbage and lettuce, have such short stems and large leaves that they appear to have no stems at all. The stems of still other plants, including potatoes, grow partly underground.

Most stems grow upright and support the leaves and reproductive organs of plants. The stems hold these parts up in the air where they can receive sunlight. Some stems grow along the ground or underground. Stems that grow above ground are called *aerial* stems, and those underground are known as *subterranean*. Aerial stems are either *woody* or *herbaceous* (nonwoody). Plants with woody stems include trees and shrubs. These plants are rigid because they contain large amounts of woody xylem tissue. Most herbaceous stems are soft and green because they contain only small amounts of xylem tissue.

In almost all plants, a stem grows in length from the end, called the *apex*. The cells that form this growth area are called the *apical meristem*. An apical meristem produces a column of new cells behind itself. These cells develop into the specialized tissues of the stem and leaves. An apical meristem and the cluster of developing leaves that surround it are called a *bud*. Buds may grow on various parts of the stem. A *terminal bud* is found at the end of a branch. A *lateral bud* develops at a point where a leaf joins the stem. This point is called a *node*. Buds may develop into new branches, leaves, or flowers. Some buds are covered with tiny overlapping leaves called *bud scales*. The bud scales protect the soft, growing tissue of the apical meristem. During the winter, the buds of many plants are *dormant* (inactive) and can be seen easily. In the spring, these buds resume their growth. See **Stem**.

**Leaves** make most of the food that plants need to live and grow. They produce food by a process called *photosynthesis*. In photosynthesis, chlorophyll in the leaves absorbs light energy from the sun. This energy is used by plants to combine water and minerals from the soil with carbon dioxide from the air. The food formed by this process is used for growth and repair, or it is stored in special areas in the stems or roots. See **Photosynthesis**.

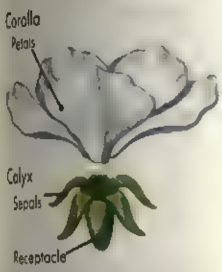
Leaves differ greatly in size and shape. Some plants have leaves less than 2.5 centimetres long and wide. The largest leaves, those of the raffia palm, grow up to 20 metres long and 2.5 metres wide. Most plants have broad, flat leaves. Many of these leaves have smooth edges, but the edges of others are toothed or wavy. Grass and certain other plants have long, slender leaves with smooth edges. A few kinds of leaves, including the needles of pine trees and the spines of cactuses, are rounded and have sharp ends.

Most leaves are arranged in a definite pattern on a plant. The leaves of many kinds of plants grow in an *alternate* or a *spiral* pattern. In both these patterns, only one leaf forms at each node. On plants with an alternate pattern, a leaf appears first on one side of the stem and then on the other side. On plants with a spiral pattern, the leaves seem to encircle the stem as they grow up the plant. If two leaves grow from opposite sides of the same node, the plant has an *opposite* arrangement of leaves. If three or more leaves grow equally spaced around a single node on the stem, the plant has a *whorled* arrangement of leaves.

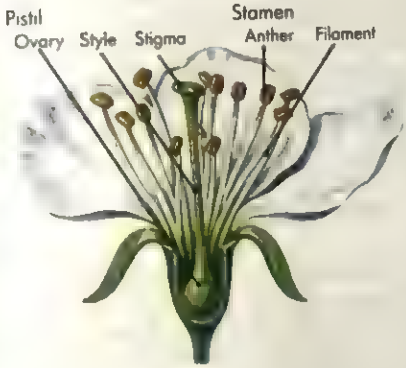
A leaf begins its life as a small bump next to the apical meristem of a stem. Most leaves develop two main parts—the *blade* and the *petiole*. The leaves of some plants also have a third part called *stipules*. The blade is the flat part of the leaf. Some leaves, called *simple* leaves, have only one blade. Leaves with two or more blades are called *compound* leaves. The petiole is the thin leafstalk that grows between the base of the blade and the stem. It carries water and food to and from the blade. Stipules are leaflike structures that grow where the petiole joins the stem. Most stipules look like tiny leaves.

A network of veins distributes water to the food-producing areas of a leaf. The veins also help support the leaf and hold its surface up to the sun. The upper and lower surfaces of a leaf are called the *epidermis* (skin). The epidermis has tiny openings called *stomata*.

**Flowers** Flowers contain the reproductive parts of flowering plants. If a plant's reproductive organs—its *stamens* and *pistils*—are in the same flower, the flower is called *perfect*. If a flower has only stamens or only pistils, it is called *imperfect*. The outer parts of a flower are shown below on the left.




All the petals of a flower make up the corolla. The sepals form the calyx. The base is called the receptacle.





Carbon dioxide, oxygen, water vapour, and other gases pass into the leaves and out of the leaves through the stomata. See **Leaf**.

**Flowers** contain the reproductive parts of flowering plants. Flowers develop from buds along the stem of a plant. Some kinds of plants produce only one flower, but others grow many large clusters of flowers. Still others, such as dandelions and daisies, have many tiny flowers that form a single, flowerlike head.

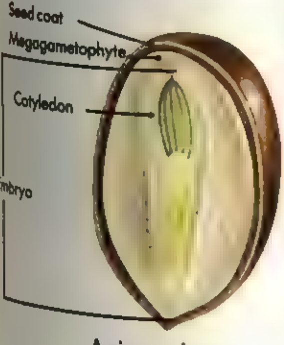
Most flowers have four main parts: (1) the *calyx*, (2) the *corolla*, (3) the *stamens*, and (4) the *pistils*. The flower parts are attached to a place on the stem called the *receptacle*.

The calyx consists of small, usually green leaflike structures called *sepals*. The sepals protect the bud of a young flower. Inside the calyx are the petals. All the petals of a flower make up the *corolla*. The petals are the largest, most colourful part of most flowers. The flower's reproductive organs—the stamens and the pistils—are attached to the receptacle inside the sepals and the petals. In many flowers, the stamens and petals are *fused* (joined together).

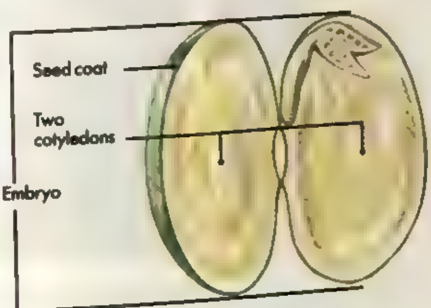
A stamen is a male reproductive organ, and a pistil is a female reproductive organ. Each stamen has an enlarged part called an *anther* that grows on the end of a long, narrow stalk called the *filament*. Pollen grains, which develop *sperm* (male sex cells), are produced in the anther. The pistils of most flowers have three main parts: (1) a flattened structure called the *stigma* at the top, (2) a slender tube called the *style* in the middle, and (3) a round base called the *ovary*. The ovary contains one or more structures called *ovules*. Egg cells form within the ovules. The ovules become *seeds* when sperm cells fertilize the egg cells. The next section of this article, *How plants reproduce*, tells how the sperm cells unite with the egg cells to begin the formation of seeds and fruit.

**Seeds** differ greatly in size and shape. Some seeds, such as those of the tobacco plant, are so small that more than 2,500 may grow in a pod less than 20 millimetres long. On the other hand, the seeds of one kind of coconut tree may weigh as much as 10 kilograms. The size of a seed has nothing to do with the size of the plant. For example, huge redwood trees, which may tower more than 110 metres, grow from seeds that measure only 1.6 millimetres long.

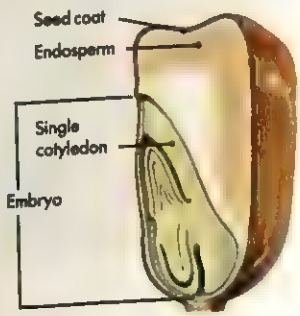
**Seeds** All seeds are either *naked* or *enclosed*. A pine seed, *below left*, is a naked seed. It forms on a pine-cone scale. There are two types of enclosed seeds—*monocots* and *dicots*. These seeds develop inside an ovary. A dicot, *centre*, has two cotyledons. A monocot, *below right*, has only one.




**A pine seed**




**A dicot (bean)**




**A monocot (maize)**

There are two main types of seeds—*naked* and *enclosed.* All cone-bearing plants have naked, or uncovered, seeds. The seeds of these plants develop on the upper side of the scales that form their cones. All flowering plants have seeds enclosed by an ovary. The ovary develops into a *fruit* as the seeds mature. The ovaries of such plants as apples, berries, and grapes develop into a fleshy fruit. In other plants, including beans and peas, the ovaries form a dry fruit. Still other plants have *aggregate* fruits. Each tiny section of an aggregate fruit, such as a raspberry, develops from a separate ovary and has its own seed.

Seeds consist of three main parts: (1) the *seed coat,* (2) the *embryo,* and (3) the *food storage tissue.* The seed coat, or outer skin, protects the embryo, which contains all the parts needed to form a new plant. The embryo also contains one or more cotyledons, or embryo leaves, which absorb food from the food storage tissue. In flowering plants, the food storage tissue is called *endosperm.* In some plants, such as peas and beans, the embryo absorbs the endosperm, and food is stored in the cotyledons. In cone-bearing plants, a tissue called the *megagametophyte* serves as a place to store food. See **Seed.**

## *How plants reproduce*

Plants create more of their own kind by either *sexual reproduction* or *asexual reproduction.* In sexual reproduction, a male sperm cell joins with a female egg cell to produce a new plant. Both the egg and the sperm cells contain *genes* (hereditary material). Genes determine many of the characteristics of a plant. A plant that is produced by sexual reproduction inherits genes from both parent plants. It is a unique individual and has traits that may be different from either parent. Asexual reproduction can occur in many ways. It often involves the division of one plant into one or more parts that become new plants. These plants inherit genes from only one parent and have exactly the same characteristics as the parent plant. This type of asexual reproduction is called vegetative propagation. Many plants reproduce both sexually and by vegetative propagation.

### Sexual reproduction

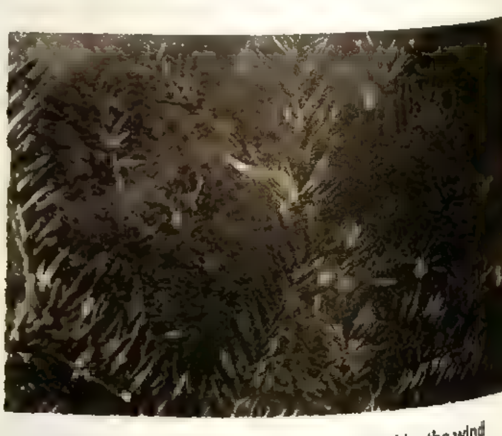
Sexual reproduction in plants occurs as a complex cycle called *alternation of generations.* It involves two distinct generations or phases. During one phase of the life cycle, the plant is called a *gametophyte,* or *gamete-bearing plant.* In most species of plants, the gametophyte is barely visible and is rarely noticed by people. It produces *gametes*—that is, the sperm and egg cells. It may produce sperm cells or egg cells, or both, depending on the species of plant. When the sperm and egg cells unite, the fertilized egg develops into the second phase of the plant's life cycle. In this phase, the plant is called a *sporophyte* or *spore-bearing plant.* When people see a plant it is most often the sporophyte phase. Sporophytes produce tiny structures called *spores* through a process of cell division called *meiosis.* The spores form in closed capsulelike structures called *sporangia.* Gametophytes develop from the spores, and the life cycle begins again.

**In seed plants,** which include flowering and cone-bearing plants, alternation of generations involves a series of complicated steps. Among these plants, only the sporophyte generation can be seen with the unaided eye. Spores are produced in the male and female reproductive organs of a plant. The spores grow into gametophytes, which remain inside the plant's reproductive organs.

***In flowering plants,*** the reproductive parts are in the flowers. A plant's stamens are its male reproductive organs. Each stamen has an enlarged tip called an *anther.* The pistil is the plant's female reproductive organ. The ovary, which forms the round base of the pistil, contains the ovules. The anthers consist of tiny structures called *microsporangia,* and the ovules contain structures called *megasporangia.* Cell divisions in the microsporangia and the megasporangia result in the production of spores.

In most species of flowering plants, one spore in each ovule grows into a microscopic female gameto-

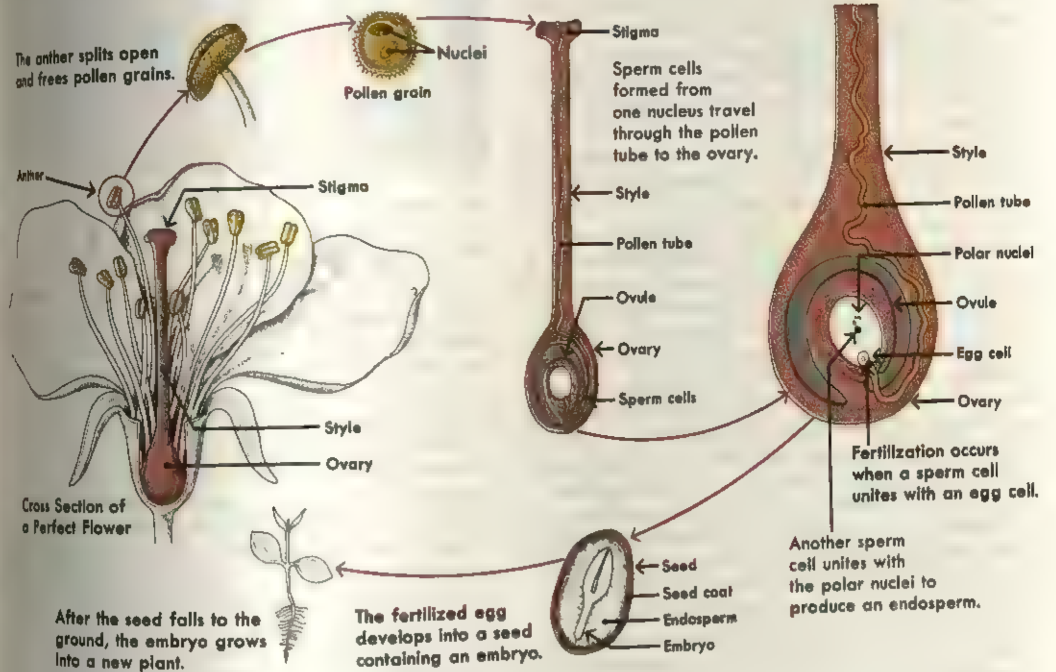
**Many flowering plants** are pollinated by bees and other animals. Grains of pollen become stuck to the animals, which carry them from flower to flower during their search for food.



**Conifers** produce pollen grains that are carried by the wind from male cones to female cones. In the above photograph, a male cone of an Austrian pine is shedding pollen.

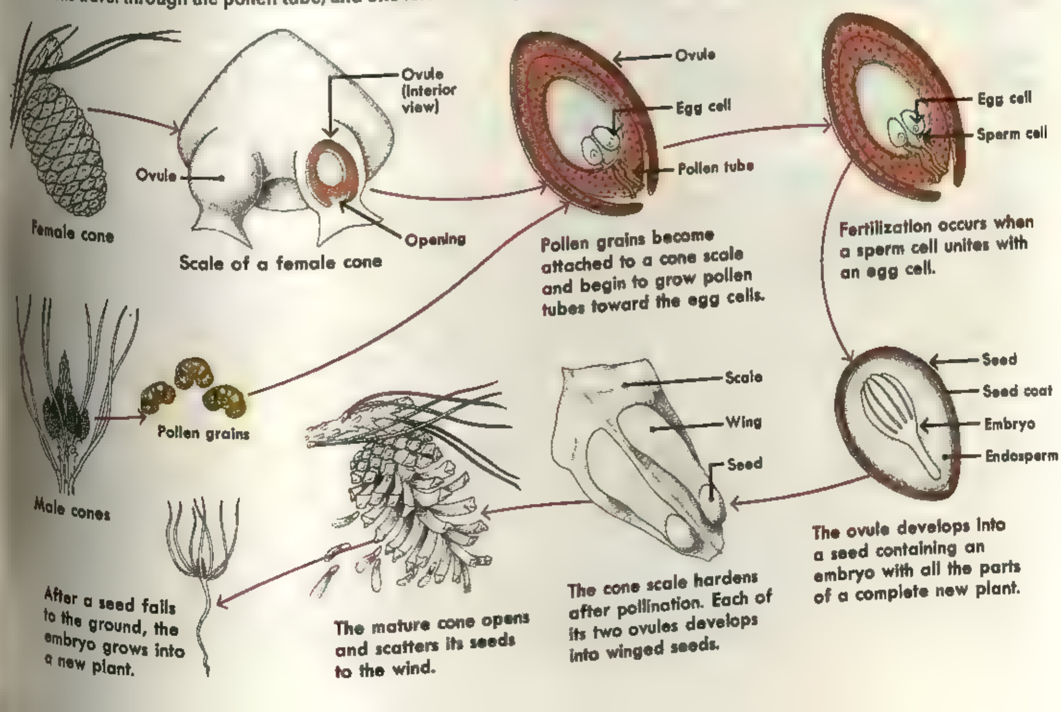
## How flowering plants reproduce

Flowering plants reproduce by a process called *pollination.* The process begins when a pollen grain from the anther of a stamen reaches the stigma of a pistil. A long, hairlike pollen tube then grows from the pollen grain to an ovule in the ovary. Sperm cells then move through the pollen tube to the ovule. When one fertilizes an egg cell, a seed begins to develop.




## How conifers reproduce

The reproductive parts of conifers develop in separate male and female cones. Pollination begins when pollen grains from a male cone enter the pollen chamber of an ovule in a female cone. Sperm cells travel through the pollen tube, and one fertilizes an egg cell to produce a seed.



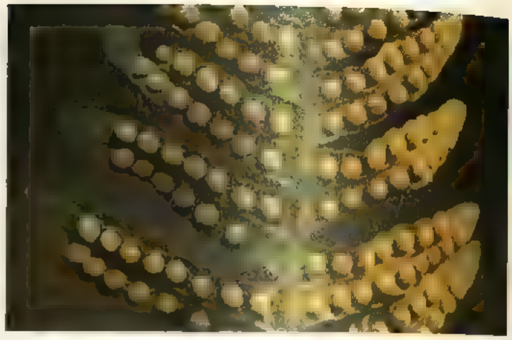
phyte. The female gametophyte produces one egg cell. In the anther, the spores, called *pollen grains,* contain microscopic male gametophytes. Each pollen grain produces two sperm cells.

For fertilization to take place, a pollen grain must be transferred from the anther to the pistil. This transfer is called *pollination.* If pollen from a flower reaches a pistil of the same flower, or a pistil of another flower on the same plant, the fertilization process is called *self-pollination.* When pollen from a flower reaches a pistil of another plant, the fertilization process is called *cross-pollination.*

In cross-pollinated plants, the pollen grains are carried from flower to flower by such animals as birds and insects, or by the wind. Many cross-pollinated plants have large flowers, a sweet scent, and sweet nectar. These features attract bats, honey possums, hummingbirds, sunbirds, and such insects as ants, bees, beetles, butterflies, and moths. As these animals move from flower to flower in search of food, they carry pollen on their bodies. Most grasses, trees, and shrubs have small, inconspicuous flowers. The wind carries their pollen. It may carry pollen as far as 160 kilometres. Some airborne pollen causes hay fever and other allergies.

If a pollen grain reaches the pistil of a plant of the same species, a pollen tube grows down through the stigma and the style to an ovule in the ovary. In the ovule, one of the two sperm cells from the pollen grain unites with the egg cell. A sporophyte embryo then begins to form. The second sperm cell unites with two structures called *polar nuclei* and starts to form the nutrient tissue that makes up the endosperm. Next, a seed coat forms around the embryo and the endosperm. See **Pollen; Seed.**

***In conifers,*** the reproductive parts are in the cones. A conifer plant has two kinds of cones. The pollen, or male, cone is the smaller and softer of the two. It also is simpler in structure. Seed, or female, cones are larger and harder than the male cones.



**Fern spores** grow in clusters called *sori* that develop on the underside of the plant's leaves, *above.* Each sorus consists of many *sporangia* that split open to release the spores.

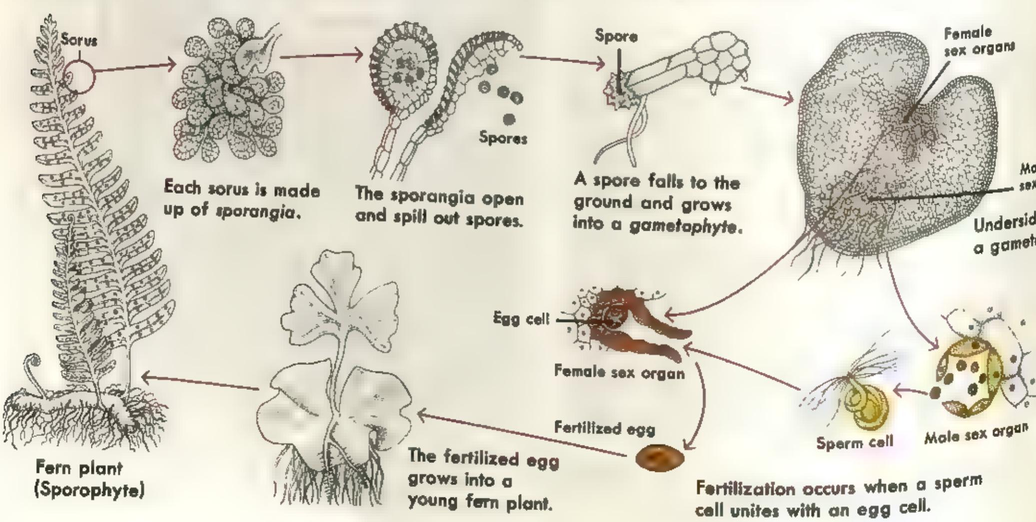
A pollen cone has many tiny sporangia that produce pollen grains. Each of the scales that make up a seed cone has two ovules on its surface. Every ovule produces a pollen grain that contains a female gametophyte. This tiny plant produces egg cells.

The wind carries pollen grains from the pollen cone to the seed cone. A pollen grain sticks to an adhesive substance near an ovule. It usually enters the pollen chamber of the ovule through an opening called the *micropyle.* The pollen grain then begins to form a pollen tube. Two sperm cells develop in the tube. After the pollen tube reaches the egg cell, one of the sperm cells fertilizes the egg. The second sperm cell disintegrates. The fertilized egg develops into a sporophyte embryo, and the ovule containing the embryo becomes a seed. The seed falls to the ground and, if conditions are favourable, a new sporophyte begins to grow.

**In ferns and mosses,** the sporophyte and gametophyte generations consist of two greatly different plants. Among ferns, the sporophytes have leaves and are much larger than the gametophytes. Clusters of sporan-

**How ferns reproduce**

Ferns reproduce by means of both spores and sex cells. The spores form on the leaves of the fern plant, which is called a *sporophyte.* A spore grows into a small plant called a *gametophyte* which, in turn, produces male and female sex cells that unite and develop into another sporophyte.



gia called *sori* form on the edges or underside of each leaf. Spores develop in the sporangia. After the spores ripen, they fall to the ground and grow into barely visible, heart-shaped gametophytes. A fern gametophyte produces both male and female sex cells. If enough moisture is present, a sperm cell swims to an egg cell and unites with it. The fertilized egg then grows into an adult sporophyte.

Among mosses, a sporophyte consists of a long, erect stalk with a podlike spore-producing container at the end. The sporophyte extends from the top of a soft, leafy, green gametophyte. It depends on the gametophyte for food and water. The gametophyte is the part of the plant community recognized as moss.

### Vegetative propagation

Plants can spread without sexual reproduction. Through vegetative propagation, a part of a plant may grow into a complete new plant. Vegetative propagation can take place because the pieces of the plant form the missing parts by a process called *regeneration.* Any part of a plant—a root, stem, leaf, or flower—may be propagated into a new plant. A plant may even grow from a single cell of another plant.

Propagation occurs most often in plants with stems that run horizontally just above or below the ground. The strawberry plant, for example, sends out long, thin stems called *runners* that grow along the surface of the soil. The runners, at points where they touch the ground, send out roots that produce *plantlets* (new leaves and stems). These plantlets are actually part of the parent plant. New plants form only when the plantlets are separated from the parent plant. Ferns, irises, many kinds of grasses, some types of shrubs, and some species of trees propagate in this way from underground stems.

Many plants that grow as weeds are able to spread rapidly by vegetative propagation. These plants are sometimes difficult to kill because they often can regrow their lost parts by regeneration. For example, a dandelion will regrow new stems and leaves even if only part of its roots are left in the soil.

Farmers use vegetative propagation to grow many valuable food crops, such as apples, bananas, oranges, and potatoes. For example, they cut potatoes into many parts, making sure that each part has at least one *eye* (bud). Each piece of potato will grow into a new potato plant. Propagation by this method produces new potato plants more quickly than is possible by planting the seeds of a potato plant.

Vegetative propagation is also widely used in gardening. Many plants, including gladioli, irises, lilies, and tulips, are propagated from bulbs or corms. These plants take longer to reach the flowering stage when grown from seeds.

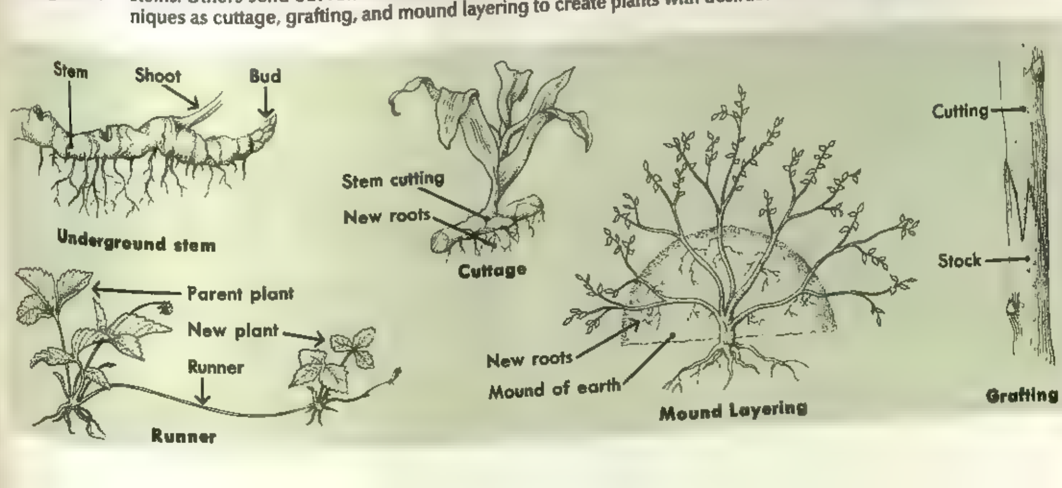
People propagate many plants by three chief methods. These methods are: (1) cuttage, (2) grafting, and (3) layering.

*Cuttage* involves the use of *cuttings* (parts of plants) taken from growing plants. Most cuttings are stems. When placed in water or moist soil, the majority of cuttings develop roots. The cutting then grows into a complete plant. Many species of garden plants and shrubs are propagated by stem cuttings.

*Grafting* also involves cuttings. But instead of putting the cutting into water or soil, it is *grafted* (attached) to another plant, called the *stock.* The stock provides the root system and lower part of the new plant. The cutting forms the upper part. Farmers use grafting to grow large numbers of some kinds of fruit, including certain varieties of apples. They take cuttings from trees that have grown the type of apples they want and graft them onto apple trees with strong root systems. For a discussion of various methods of grafting, see the *World Book* article on **Grafting**.

*Layering* is a method of growing roots for a new plant. In *mound layering,* soil is piled up around the base of a plant. The presence of the soil causes roots to sprout from the branch. The branch is then cut off and planted. In *air layering,* a cut about 8 centimetres long is made about halfway through a branch. A type of moss called sphagnum moss is placed in the cut to keep it moist, and this portion of the branch is wrapped in a waterproof covering. New roots form in the area of the cut. After they have sprouted, the branch is cut off and planted.

**Vegetative propagation** Many plants reproduce by vegetative propagation. Some develop new shoots from underground stems. Others send out runners that take root and grow into new plants. People use such techniques as cuttage, grafting, and mound layering to create plants with desirable characteristics.



# How plants grow

Plants can be divided into two groups, based on how they get their food. All green plants are called *autotrophs.* They contain chlorophyll, which enables them to capture the sunlight used in producing the food and other materials they need for growth. Other kinds of plants, called *heterotrophs,* lack chlorophyll and cannot make their own food. They are either parasites or saprophytes.

This section discusses the four major processes that take place in the growth of most kinds of green plants. These processes are (1) *germination,* (2) *water movement,* (3) *photosynthesis,* and (4) *respiration.* The section also discusses how a plant's heredity and environment affect its growth.

**Germination** is the sprouting of a seed. Most seeds have a period of inactivity called *dormancy* before they start to grow. In most parts of the world, this period lasts through the winter. Then, after spring arrives, the seeds start to germinate.

Seeds need three things to grow: (1) a proper temperature, (2) moisture, and (3) oxygen. Most seeds, like most kinds of plants, grow best in a temperature of between 18° C and 30° C. The seeds of plants that live in cold climates may germinate at lower temperatures, and those of tropical regions may sprout at higher temperatures. Seeds receive the moisture they need from the ground. The moisture softens the seed coat, allowing the growing parts to break through. Moisture also prepares certain materials in the seed for their part in seed growth. If a seed receives too much water, it may begin to rot. If it receives too little, germination may take place slowly or not at all. Seeds need oxygen for the changes that take place within them during germination.

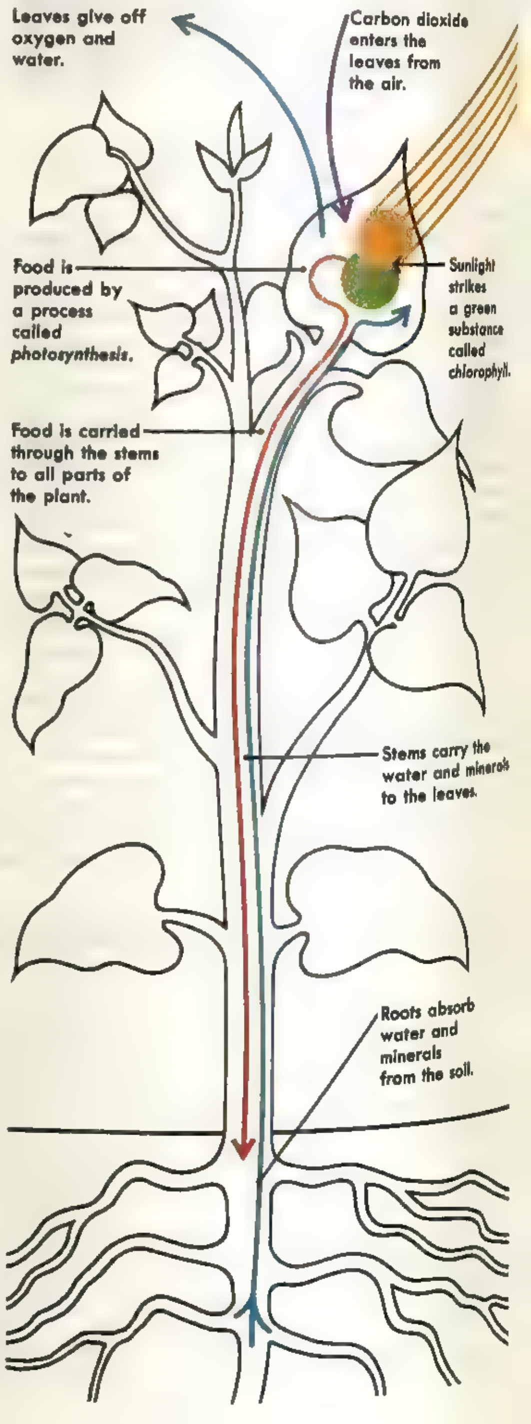
The embryo of a seed has all the parts needed to produce a young plant. It may have either one or more cotyledons, which digest food from the endosperm for the growing seedling. The seed absorbs water, which makes it swell. The swelling splits the seed coat, and a tiny seedling appears. The lower part of the seedling, called the *hypocotyl,* develops into the primary root. This root anchors the seedling in the ground and develops a root system that supplies water and minerals to the seedling. Next, the upper part of the seedling, called the *epicotyl,* begins to grow upward. At the tip of the epicotyl is the *plumule,* the bud that produces the first leaves. In some plants, such as the many kinds of beans, the growth of the epicotyl carries the cotyledons above ground. In maize and other plants, cotyledons remain underground, within the seed. After a seedling has developed its own roots and leaves, it can make its own food. It no longer needs cotyledons to supply nourishment.

Most plants grow in length only at the tips of their roots and branches. The cells in these areas are called *meristematic* cells. They divide and grow rapidly and develop into the various tissues that make up an adult plant. In trees and other plants that increase in thickness, new layers of cells form between the bark and wood. This area is the *cambium.* New layers of cells are made as the cambium grows each year. These layers form the woody rings that enable people to tell the age of a tree.

Some kinds of plants, called *perennial* plants, live for many years. Most perennials produce seeds yearly.

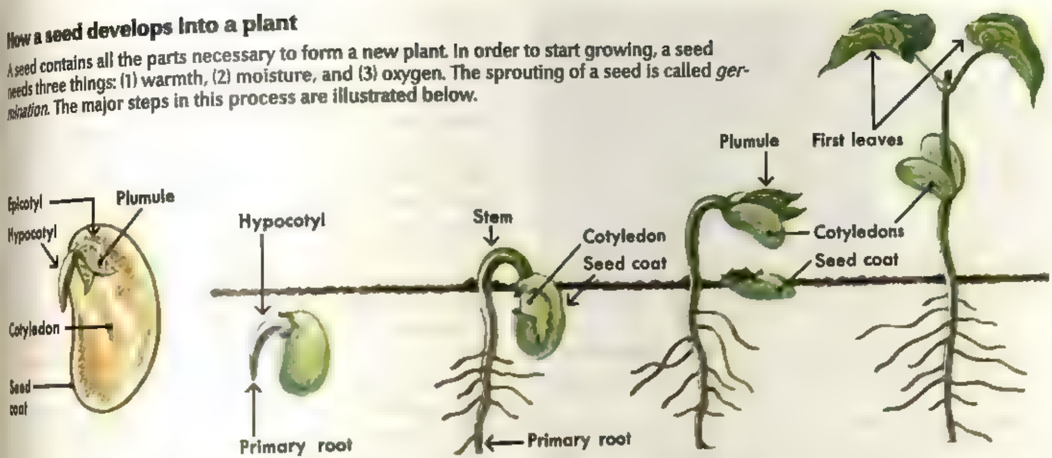
### Growth of a green plant

Green plants make the food they need by a process called *photosynthesis.* This process, which occurs chiefly in the leaves, is triggered by chlorophyll. The chlorophyll interacts with water from the soil, carbon dioxide from the air, and light from the sun to produce food. Most plants have special conducting tissue that carries food through the stems to all parts of the plant. The food is needed for growth, repair, and storage.



### How a seed develops into a plant

A seed contains all the parts necessary to form a new plant. In order to start growing, a seed needs three things: (1) warmth, (2) moisture, and (3) oxygen. The sprouting of a seed is called *germination.* The major steps in this process are illustrated below.




This cross section of a bean shows the embryo in a seed coat.

The seed splits and the hypocotyl forms the primary root.

As the root grows down, the stem breaks through the soil.

The cotyledons free the plumule, and the seed coat drops off.

As the stem grows upward, the plumule forms the first leaves.

Other species, called *annuals,* live for only about one year. Still other species, called *biennials,* live for two years. Most annuals and biennials produce seeds only once. See **Annual; Biennial; Perennial.**

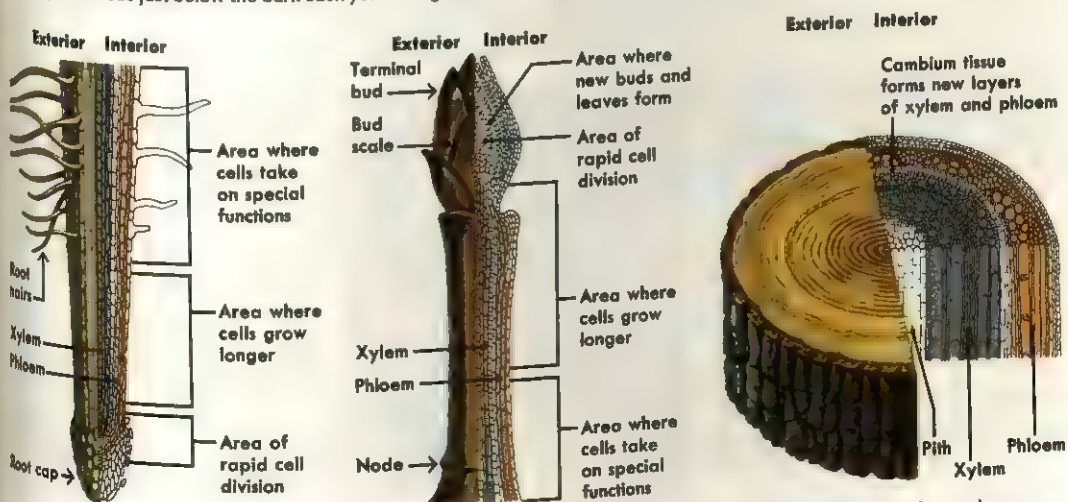
**Water movement.** Plants must have a continuous supply of water. Each individual plant cell contains a large amount of water. Without this water, the cells could not carry on the many processes that take place within a plant. Water also carries important materials from one part of a plant to another.

Most water enters a plant through the roots. Tiny root hairs absorb moisture and certain minerals from the soil by a process called *osmosis* (see **Osmosis**). In vascular plants—that is, plants with special conducting tissues—these materials are transported through the xylem tissue of the roots and stems to the leaves. There, water and minerals are used in making food. Water also carries this food through the phloem tissue to other parts of the plant.

Plants give off water through a process called *transpiration.* Most of this water escapes through the stomata on the surfaces of the leaves. Scientists estimate that maize gives off more than 3,000,000 litres per hectare by transpiration during a growing season. Some botanists believe this water loss prevents the leaves from overheating in sunlight.

### How plants grow longer and wider

Most plants grow only at the tips of their roots and stems. Cells in these areas grow rapidly, forming the various tissues that make up an adult plant. Trees and other plants that grow wider develop a new layer of tissue just below the bark each year. The growing parts of plants are shown below.




Roots push deeper and deeper into the soil as cells just above the root cap divide and grow longer.

Stems grow longer as cells in the terminal bud divide rapidly. These cells will develop into buds, flowers, and leaves.

Woody stems grow thicker each year. New growth comes from the rapidly dividing cells that make up the cambium.

**Photosynthesis** is the process by which plants make food. The word *photosynthesis* means *putting together with light.* In green plants, sunlight captured by chlorophyll enables carbon dioxide from the air to unite with water and minerals from the soil and create food. This process also releases oxygen into the air. People and animals must have this oxygen to breathe.

Most photosynthesis takes place in small bodies called *chloroplasts* within the cells of plant leaves. These chloroplasts contain chlorophyll, which absorbs sunlight. Energy from the sun splits water molecules into hydrogen and oxygen. The hydrogen joins with carbon from the carbon dioxide to produce sugar. The sugar helps a plant make the fat, protein, starch, vitamins, and other materials that it needs to survive. See **Photosynthesis**.

Some plants, called *parasites* and *saprophytes,* have little or no chlorophyll and cannot produce their own food through photosynthesis. These plants must rely on outside sources for food. Parasites attach to living plants and take the nutrients they need from these plants. Saprophytes grow on dead and decaying organisms, or use organic substances produced by living organisms for food.

Mistletoe and dodder are common parasites found in many parts of the world. Mistletoe grows on the trunks and branches of many trees. It is called a *partial parasite* because it also makes some of its own food. Indian pipe is a saprophyte that grows near fungi. It uses organic materials produced by fungi for food. A plant called giant rafflesia is a parasite that grows on the roots and stems of other plants. It bears the largest flower of any known plant. Rafflesia flowers may grow over 90 centimetres wide.

**Respiration** breaks down food and releases energy for a plant. The plant uses the energy for growth, reproduction, and repair. Respiration involves the breakdown of sugar. Some of the products resulting from this breakdown combine with oxygen, releasing carbon dioxide, energy, and water. Unlike photosynthesis, which takes place only during daylight, respiration goes on day and night throughout the life of a plant. Respiration increases rapidly with the spring growth of buds and leaves, and it decreases as winter approaches.

**Factors affecting plant growth.** A plant's growth is shaped by both its heredity and its environment. A plant's heredity, for example, determines such characteristics as a flower's colour and general size. These hereditary factors are passed on from generation to generation. Environmental factors include sunlight, climate, and soil condition.

***Hereditary factors.*** Within the nucleus of all plant cells are tiny bodies called *chromosomes* that contain hereditary units called *genes.* These bodies contain "instructions" that direct the growth of the plant. As the cells divide and multiply, the "instructions" are passed on to each new cell. See **Cell; Heredity**.

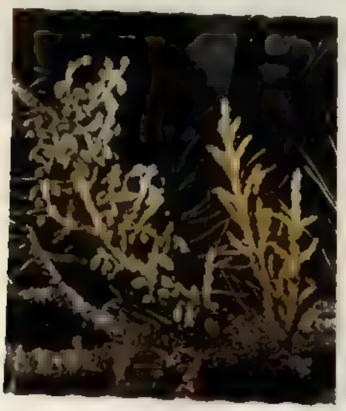
Substances made within a plant also play a part in regulating plant growth. These substances, called *hormones,* control such activities as the growing of roots and the production of flowers and fruit. Botanists do not know exactly how all plant hormones work. But they have learned that certain hormones, called *auxins,* affect the growth of buds, leaves, roots, and stems. Other growth hormones, called *gibberellins,* make plants grow larger, cause blossoming, and speed seed germination. Still other hormones called *cytokinins* make plant cells divide.

***Environmental factors.*** All plants need light, a suitable climate, and an ample supply of water and minerals from the soil. But some species grow best in the sun, and others thrive in the shade. Plants also differ in the amount of water they require and in the temperatures they can survive. Such environmental factors affect the rate of growth, the size, and the reproduction of all plants.

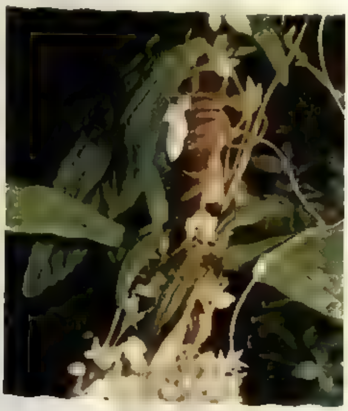
The growth of plants also is affected by the length of the periods of light and dark they receive. Some plants,

**How nongreen plants get their food**

Nongreen plants cannot make their food. *Parasites* get food from other living things. *Saprophytes* live on decaying organisms or on substances made by living organisms.



**Mistletoe,** *above,* grows on trees. It is a partial parasite because it takes water and minerals from trees but makes food in its own leaves.



**The dodder plant,** *above,* is a parasite. This plant grows in tangled masses. It gets its food by inserting specialized roots called *suckers* into other plants.

**The Indian pipe,** *above,* is a saprophyte. This plant grows near fungi and uses the organic materials produced by the fungi for food.

including lettuce and spinach, bloom only when the *photoperiod* (period of daylight) is long. Such plants are called *long-day* plants. On the other hand, asters, chrysanthemums, and poinsettias are *short-day* plants. They bloom only when the dark period is long. Still other plants, among them marigolds and tomatoes, are not affected by the length of the photoperiod. They are called *day-neutral* plants.

Plants also are affected in other ways by their environment. For example, a plant may display a bending movement called a *tropism*. In a tropism, an outside *stimulus* (force) causes a plant to bend in one direction. A plant may have either a *positive* or a *negative* tropism, depending on whether the plant bends toward or away from the stimulus. Tropisms are named according to the stimuli that cause them. *Phototropism* is bending caused by light, *geotropism* is caused by gravity, and *hydrotropism* is caused by water.

A plant placed in a window exhibits positive phototropism when its stems and leaves grow toward the source of light. Roots, on the other hand, display negative phototropism and grow away from light. However, roots demonstrate positive geotropism. Even if a seed or bulb is planted upside down, its roots grow downward—toward the source of gravity. The stem of the same bulb shows negative geotropism by growing upward—away from the source of gravity. Hydrotropism occurs chiefly in roots and is almost always positive. See Tropism.

Some plants are affected by being touched. When the sensitive plant, *Mimosa pudica*, is touched, its leaflets quickly fold and its branches fall against its stem. A change in pressure within certain cells of the plant causes this action. After the stimulus has been removed, the plant's branches and leaflets return to their original position.

**The amount of daylight** received by a plant affects its growth. The petunias above are the same age. They have received, *from left to right*, 8, 12, 16, 20, and 24 hours of light per day.

**Hormones** can affect plant growth. In the above experiment, the plant cutting on the left was treated with the hormone *naphthalene acetic acid*. The cutting on the right was untreated.

**Geotropism**, the effect of gravity on plants, can be shown by planting maize kernels upside down, *above*. Roots have positive geotropism and grow downward toward the source of gravity.

**Phototropism** is a bending movement caused by light. The stem of the coleus plant shown above demonstrates positive phototropism. It is growing toward a fixed source of light.

## How plants change

Plants—like animals—compete with one another for sunlight, water, and other necessities of life. Some plants—like some animals—are better able than others to grow and reproduce. After thousands of years, those that survive may differ greatly from their ancestors. The surviving plants have adapted to their environment through a process called *natural selection* or survival of the fittest (see **Natural selection**).

This section traces the early history of plants and discusses important forms of plant adaptation for water storage and seed *dispersal* (scattering). This section also describes an unusual group of plants that adapted in such a way that they capture and eat insects. It ends with a discussion of some of the ways that people have changed plants.

**Early plants.** The first land plants appeared on the earth over 430 million years ago during the Palaeozoic Era. These plants were very simple and did not resemble any of the plants we see today. They probably had a sticklike plant body and lacked the specialized water-conducting tissue of vascular plants. Many botanists believe these early land plants were the ancestors of primitive vascular plants. The first vascular plants, called *Rhyniophytes,* did not have leaves or roots. They consisted of both stems that grew along the ground and stems that grew upright with Y-shaped branches. These plants probably grew to a height of between 60 and 90 centimetres.

Larger plants called *Trimerophytes* may have developed from the Rhyniophytes. The Trimerophytes had a more complex plant body with numerous stems and branches. But they did not have leaves or roots. Other small vascular plants called *Zosterophyllophytes* appeared shortly after the Rhyniophytes and also may have descended from them. Some botanists believe Trimerophytes and Zosterophyllophytes are the ancestors of all vascular plants that exist today. They think that ferns, horsetails, and seed-bearing plants *evolved* (developed through progressive change) from Trimerophytes about 408 to 360 million years ago. Club mosses, quillworts, and selaginellas are believed to have evolved from Zosterophyllophytes about the same time.

When the first vascular plants began to grow successfully on much of the land, life on earth was very different than it is today. No leaves rustled in the breeze, few insects crawled about, and no *vertebrates* (animals with backbones) lived on land. However, as conditions on the earth changed, new plants and animals developed. During the Carboniferous Period, about 360 to 290 million years ago, more complex and larger vascular plants evolved. Great forests of lycophyte trees, ferns, horsetails, and early seed plants covered the earth. The huge plants of this period died and accumulated in vast swamps. They later formed large coal deposits. Most of the coal found in Europe and the Eastern and Midwestern United States is made up of these plants.

**About 410 million years ago,** forests began to grow in swampy regions of the world. The plants of these early forests included the ancestors of present-day club mosses, horsetails, and ferns. The first amphibians and insects also appeared about the same time.

Gymnosperms became the most plentiful plants during the Mesozoic Era, beginning about 240 million years ago. Conifers, cycads, and ginkgoes were among the most important plants. They served as food for the great dinosaurs that roamed the land during this period. Many now-extinct types of gymnosperms also flourished. The first angiosperms, or flowering plants, appeared at the end of the Mesozoic Era. Among them were magnolias, sycamores, willows, water lilies, and many other present-day flowering plants.

During the Cenozoic Era, beginning about 63 million years ago, forests of angiosperms covered much of the tropical and temperate regions of the earth. Grasslands and large grazing animals began to appear late in the Cenozoic Era. Some scientists believe that humanlike creatures appeared on the earth about 5 million years ago and lived in the regions between the forests and grasslands.

**Water storage.** Over the years, many species of plants have developed special methods for collecting and storing water that have enabled them to survive in areas of little rainfall. Some cactuses, for example, have roots that spread over large areas just below the surface of the ground. These roots quickly absorb water from the light rains and sudden floods that occur in the desert. Cactuses store the water in their fleshy stems.

Through natural selection, the leaves of cactuses evolved into spines. As a result of this adaptation, cactuses have less green surface than do most plants of their size—and they lose less water through transpiration. Because cactuses have such specially shaped leaves, they carry out photosynthesis in their stems. During photosynthesis, cactuses use their stored water supply if water from their roots is not available.

Plants of the tundra also have adapted to the dry conditions created by frozen soils. The surfaces of their leaves are especially resistant to water loss. They are either hard and glossy or very hairy. In addition, tundra plants grow close to the ground, where they are covered by snow and thus protected from the strong winds of these regions.

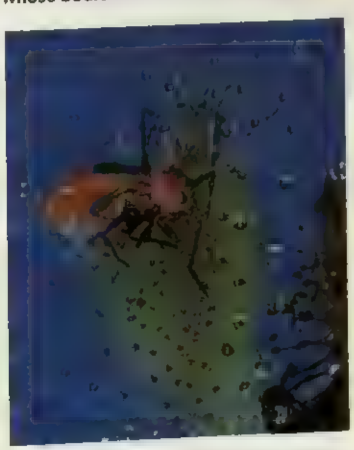
**Desert plants** have many features that enable them to survive in extremely dry areas. The barrel cactuses, *above,* store water from infrequent rains in their thick, fleshy stems.

**Seed dispersal.** Seeds play an important part in the distribution of plants to nearly every part of the world. If seeds simply fell to the ground, all the plants of each species would be found in the same area. People have also helped spread seeds by taking food crops and certain other plants wherever they have settled.

**Plants that eat insects**

Insect-eating plants grow in soil that lacks important minerals, especially nitrogen. Special organs enable these plants to trap and digest insects whose bodies contain the minerals.

**Insects caught** in a pitcher plant, *above,* drown in rain water collected in the plant's slender, tube-shaped leaves.



**A sundew plant,** *above,* has sticky hairs on its leaves that trap insects and then cover them with digestive fluids.

**The leaves of Venus's-flytrap** close quickly on an insect, *above.* They open after the victim has been digested.

Seeds have many features that have helped them be scattered across large regions. The wind carries many seeds, including the winglike ones of the maple tree and the fluffy seeds of the dandelion and of the willow tree. Some seeds, such as those of the coconut, may float on water from one land area to another.

Animals also help distribute seeds. Some plants have burs and sticky substances which cling to the fur or feathers of animals that migrate from one region to another. Many kinds of animals eat berries and fruit but do not digest the seeds. The seeds are dispersed as part of the body waste of these animals.

A few species of plants distribute their own seeds. For example, flowers called balsams and touch-me-nots shoot out their seeds at the slightest touch.

**Insect-eating plants** grow chiefly in areas where the soil lacks an adequate supply of important minerals, especially nitrogen. These plants have adapted so that they can obtain needed minerals by trapping and digesting insects in their leaves. These *insectivorous* plants also manufacture their own food by photosynthesis. Insect-eating plants include the pitcher plant, the sundew, and Venus's-flytrap.

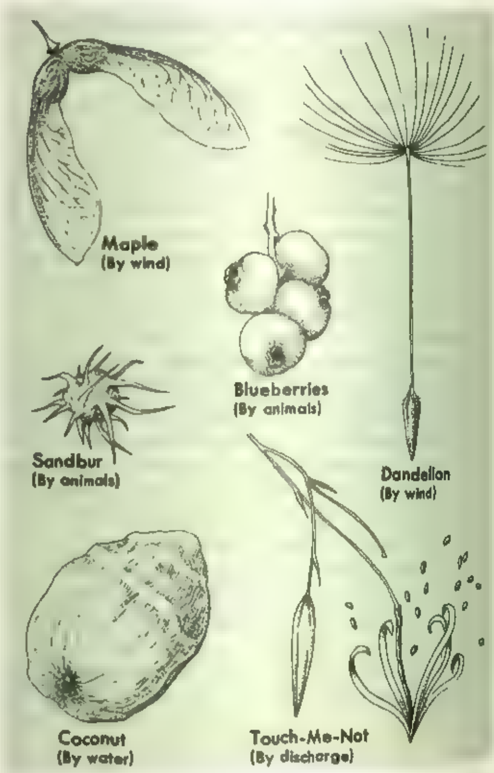
Pitcher plants have tube-shaped leaves that collect rain water. Sweet substances around the rim of each tube attract insects to the plant. After an insect enters the tube, tiny, downward-pointing hairs keep the struggling victim from escaping. In time, the insect becomes exhausted, slides into the water, and drowns. The plant then digests the insect by means of a fluid secreted by glands located in the leaves.

The leaves of the sundew plant grow hairs that give off a sticky substance that contains digestive juices. When an insect gets stuck on this substance, the hairs wrap around it. More fluid covers and suffocates the insect, which is then gradually digested by the sundew plant.

Venus's-flytrap has hinged leaves that trap insects. The inside of each leaf has hairs, and the rim is edged with sharp bristles. When an insect lands on the hairs, the two halves of the leaf close like a trap, with the bristles interlocking. After the plant has digested the insect, the leaves open up again.

**How seeds are dispersed**

Seeds have a variety of features that help them to be scattered to almost every part of the world. People and animals also help disperse seeds in a number of ways.




**How people have changed plants.** People began to play an important role in changing plants about 10,000 years ago, when they learned to grow food by farming. Early farmers noted that some plants grew better than others. They saved seeds from these plants to grow new ones. The basic food crops of the world were developed in this way. For example, the Indians of the Americas developed tiny ears of maize into large cobs with many kernels. By the time Christopher Columbus reached the New World in 1492, this improved maize was being grown over large areas of the Americas.

The scientific study of plants has greatly aided our attempts to make plants more useful and attractive. For example, an Austrian monk named Gregor J. Mendel conducted experiments on garden peas in the mid-1800's that laid the foundation for the field of *genetics*, the science of heredity. Using the laws of genetics, scientists have greatly increased the yield of such crops as maize, rice, and wheat. They also have developed plants that can resist the attacks of various diseases and insects. In 1970, Norman E. Borlaug, an American agricultural scientist, received the Nobel Peace Prize for developing high-yield, disease-resistant wheat.

**Large and succulent corn-on-the-cob** was developed by the American Indians from tiny cobs of wild maize, *above.* Today, botanists seek ways to improve crop yields and develop disease-resistant plants.

Various kinds of plant enemies attack and injure almost all species of plants throughout the world. Diseases and insect pests rank as the major enemies of plants. They cause serious, widespread damage to agricultural, garden, and ornamental plants, many of which have lost the natural defences present in wild plants. In the United States, diseases, insects, and other plant enemies cause crop losses totaling about 30 billion U.S. dollars yearly. Diseases reduce the nation's total annual crop production by 10 to 15 per cent, and insects reduce it by about another 15 per cent.

Widespread outbreaks of plant diseases can cause famine. During the 1840's, about 750,000 people in Ireland died after a fungus disease destroyed the nation's potato crop. Other diseases have killed large numbers of certain species of plants. A fungus called Dutch elm disease has destroyed elm trees over much of Britain. Another called *chestnut blight* has destroyed chestnut trees throughout North America.

Insects also severely damage large numbers of plants. For example, swarms of grasshoppers and locusts may destroy all the plants in areas of the tropics and subtropics. Caterpillars do a lot of damage by feeding on the leaves of trees and bushes. In addition, many plants are injured or killed by animal pests, including mites, rabbits, and rodents.

**Diseases** in plants are caused by many kinds of microorganisms, including certain fungi, bacteria, viruses, and small worms called *nematodes*. Fungi cause more plant diseases than the other microorganisms. Viruses also infect plants with serious diseases.

Certain conditions in the environment can damage plant tissues and weaken plants so that they are more easily infected by disease-causing microorganisms. Such conditions include air pollution, unusually high or low temperatures, lack of proper nutrients in the soil, and low levels of light or oxygen.

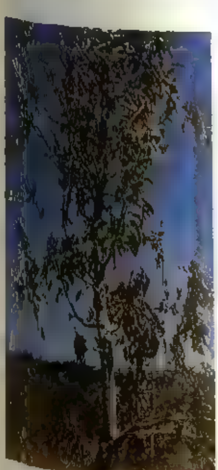
Plant diseases may affect every part of the plant. Many diseases interfere with the plant's ability to carry out photosynthesis by damaging leaves or by blocking the flow of water or nutrients to stems and leaves. Fungi, bacteria, or viruses may invade plant tissues and kill cells in a small area. For example, dead spots on leaves and fruit, or yellowing and death of leaves at the edges, indicate places where microorganisms have killed plant cells. Abnormal growths, such as *galls* and *knots*, on roots, stems, and other parts of the plant also signal places of infection. Fungi or bacteria that invade the roots, stems, and leaves can prevent xylem tissue from transporting water throughout the plant. As a result, the leaves, stems, and flowers may wilt or suddenly die. In addition, fungi may secrete *toxins* (poisons) that cause large parts of the plant to die.

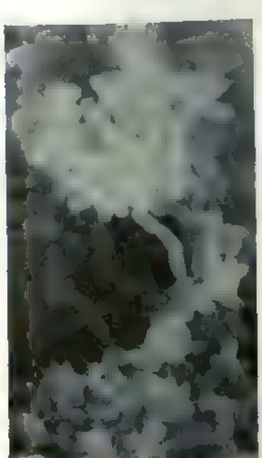
Fungal diseases are spread from plant to plant by the spores of the fungi. These spores are carried by insects, rain, wind, and even people. Some bacteria and viruses are spread in the same way. Nematodes not only cause certain diseases but also transmit viruses from diseased to healthy plants. Some bacteria and fungi live on plant refuse in the soil and infect healthy plants. Others are carried on the seeds of plants.

Some diseased plants cause serious illness when eaten by human beings and animals. For example, a fungus called *ergot* infects wheat, barley, and rye. It produces chemicals that can cause *ergotism*, an illness that afflicts people who eat bread made from the infected grain. Other fungi, if enough are present on food or animal feed, produce harmful chemicals called *mycotoxins*. Scientists are conducting extensive research on these chemicals, some of which may cause cancer.

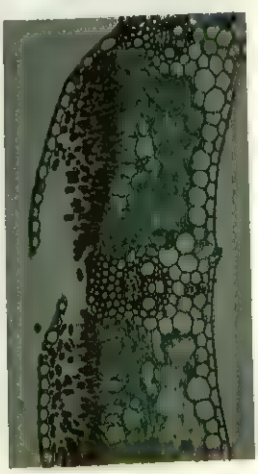
**Nutrient deficiencies.** Plants suffer from *nutrient deficiencies* when they cannot obtain certain minerals and chemicals from the soil. Nutrient deficiencies are harmful to plants in a number of ways. They may cause changes in leaf colour, reduction in the size of leaves, dead spots on leaves and stems, reduced growth, and wilting. Each symptom often can be linked to the lack of a specific chemical, usually nitrogen or potassium.

Plants may also be affected by *chemical toxicity* when the soil contains too much of certain chemicals or minerals. For example, most plants require very small amounts of zinc, iron, and copper. But people some-





**A bacterial disease called fire blight** has killed most of the leaves of the pear tree on the left. The photograph on the right shows hundreds of the microscopic fire blight bacteria.



**A fungal disease called black stem rust** attacks wheat stalks, *left*. A photograph of an infected stalk seen under a microscope, *right*, shows the reddish-black fungal spores.

times introduce excessive amounts of these substances into the soil during the mining and smelting of ore. As a result, large numbers of plants are killed. Zinc also may accumulate in the soil below fences that are coated with the mineral to prevent them from rusting. The zinc builds up in a narrow strip of soil and eventually destroys many of the plants growing there.

Some soils are naturally too rich in metals. For example, areas of *serpentine,* a volcanic rock that contains heavy metals, are common in western North America. These areas form *barrens,* where few plants survive.

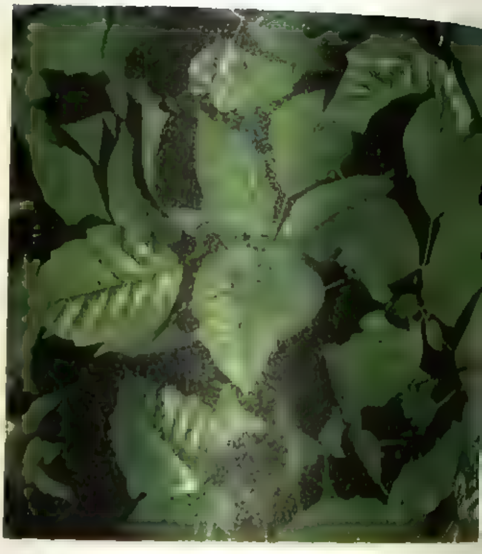
**Pests.** Insects damage or destroy plants in a number of ways. Insects with chewing mouthparts, such as beetles and grasshoppers, eat holes in leaves and stems. Other insects have piercing and sucking mouthparts with which they pierce plants and consume the plant juices. Some insects feed on flowers and fruit. The destruction of leaves by insects affects the growth and yield of crops because photosynthesis is reduced. In addition, wounds made in plants by insects provide places for disease-causing organisms to enter the plants easily.

Some insects secrete poisons or other chemical substances while feeding. These secretions may cause galls on leaves or roots or give leaves a "burned" appearance. Other insects interrupt the flow of food and water in plants by feeding on phloem and xylem tissue.

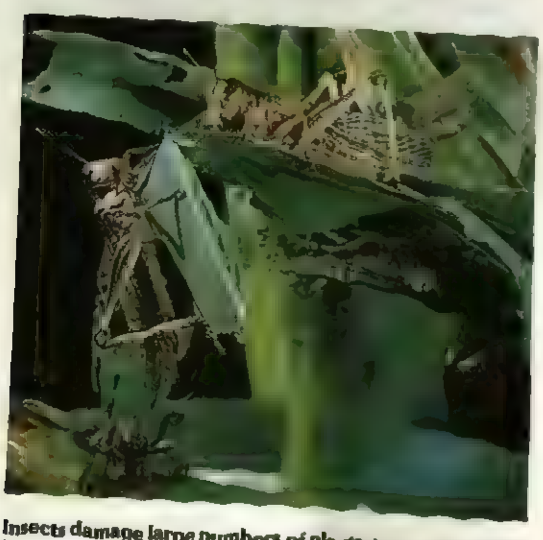
Mites, which have sucking mouthparts, injure plants by feeding on them. Rabbits and rodents gnaw on plants. Some kinds of rodents burrow into the soil and feed on the roots, seeds, and bulbs of plants.

**How plants protect themselves.** Insects and many other animals eat plants. To avoid being eaten, many species of plants have developed physical and chemical defences. Many plants also protect themselves through the timing of when they produce flowers and fruit.

Physical defences of plants include such structures as spines, thorns, and prickles. These structures, which are usually modified leaves or branches, prevent attacks by large plant-eating animals. Heavy coatings of wax or dense, stiff hairs on leaves and stems may repel smaller animals, especially insects. Some plants, including grasses, accumulate a hard mineral called *silica* in their leaves. The silica makes the leaves difficult for animals to chew and rapidly wears down their teeth.



**The leaves and stems of poison ivy,** *above,* contain a poisonous oil that is extremely irritating to the skin. The oil helps protect the plant from animals and human beings.



**Insects damage large numbers of plants.** Locusts, shown here devouring the leaves of a maize plant, are among the most destructive pests. Swarms of locusts can destroy an entire crop.

Certain species of plants obtain protection from animal enemies through a relationship called *mutualism.* In this relationship, the plant provides a special type of food for a particular group of insects. The insects, in turn, protect the plant from other animals. One example of plant-insect mutualism is the relationship between ants and acacia trees in some dry regions of the world. Ants live in hollow thorns on the acacia trees, and the leaves of the trees release a sugar solution for the ants to eat. In return, the ants clear the ground around each tree and attack any other animals that enter the cleared area or that land on the trees.

Plants have a wide variety of chemical defences against animals. The leaves and fruit of citrus plants produce sticky, strong-smelling oils that discourage many insects. Many plants contain chemicals that have an unpleasant taste or are poisonous. Such plants include nightshade, foxglove, yew, and many weeds.

Insects can quickly become immune to the chemicals plants produce. In some cases, certain kinds of insects develop a means of breaking down the toxic compounds produced by the plants. As a result, plants continually develop new chemical compounds by altering existing ones. Some scientists describe this process as a biological "arms race" between plants and their predators. In other cases, the "arms race" between an insect and plant has resulted in a unique relationship. For example, plants in the milkweed family produce a milky sap that contains poisonous chemicals. The chemicals prevent most insects from eating the plants. However, caterpillars of monarch butterflies are able to eat milkweed plants and store the poison in their bodies. The poison makes monarch butterflies distasteful and so protects them from many predators.

**Camouflage** helps protect certain plants from animals that feed on them. This photograph shows five living rock cactuses. Their colour and shape make them barely distinguishable from surrounding rocks.

Many plants try to ensure the survival of their seeds through the timing of flower and fruit production. Some plants produce flowers and fruit very early in the growing season, when insect populations are small. Other plants produce so many seeds that animals cannot eat them all. For example, oak trees produce a great number of acorns every few years. When acorns are abundant, squirrels and other animals cannot eat all of them and some acorns survive to grow into new oak trees. In other years, oak trees do not produce an abundance of acorns and thus prevent animals from relying on acorns for food. If the trees produced a surplus of acorns each year, the animal population would increase and all the acorns would be eaten.

**Control of diseases and pests.** People fight plant diseases and pest damage by means of (1) genetic methods, (2) physical methods, (3) sanitation, (4) chemicals, (5) biological control, and (6) quarantine laws.

**Chemicals** play a major role in controlling plant enemies. A crop duster, *above*, can rapidly spray an entire field with chemicals that protect against various diseases and pests.

Genetic methods include the development of resistant varieties of plants by plant breeders. Plant breeders cross resistant plants with other varieties of the same species to develop new varieties that combine resistance to diseases with high yield and other desirable characteristics. Such efforts by plant breeders have resulted in the development of high-yield, rust-resistant wheats, for example.

Physical methods include such barriers against plant pests as sticky bands of paper that trap insects, and wire guards to keep rodents away. Plant growers also gather and destroy insects and insect eggs found on plants. Crop rotation and ploughing help prevent plant enemies from overpopulating the soil.

Sanitation includes destroying diseased plants and disinfecting planting equipment. In addition, refuse is removed from a growing area. This removal eliminates places where insects and disease-causing organisms may reproduce.

Chemicals make up the largest part of almost every programme to control plant enemies. Diseases and pests may attack suddenly, and chemicals may be the only means of saving the plants. Many chemicals protect plants from diseases and pests. They include bactericides, fungicides, insecticides, nematocides, and rodenticides. In many countries, such chemicals must be approved by an environmental protection agency before they can be marketed.

Biological control involves the use of natural processes to fight the insects and disease organisms that attack plants. For example, certain bacteria and viruses that cause diseases in beetles and caterpillars may be introduced into an area to control those insects. Similarly, animals that prey on insects may be introduced to control plant enemies. Another example of biological control is the capture of insects in traps baited with *sex attractants,* the natural chemicals that insects secrete to attract mates.

Quarantine laws regulate the shipment of plants between countries. These laws require inspection of plants to prevent the introduction and spread of plant diseases and insect pests.

# Classification of plants

Botanists classify plants by grouping them according to their shared similarities. Such an arrangement provides a logical way to organize information about plants and to show how different plants are related to each other.

Most botanists group plants by their overall appearance, their internal structure, and the form of their reproductive organs. However, not all botanists agree on how plants should be divided, and there are a number of different classifications of the plant kingdom. One frequently used classification system is described below. This system classifies plants into 10 groups or *divisions*. A division is the same grouping as a phylum in the animal kingdom.

One division, Bryophyta, is made up of *nonvascular plants*. These plants lack xylem and phloem tissues that carry water and food from one part of the plant body to another. All other divisions of the plant kingdom are made up of *vascular plants* that contain these specialized tissues.

## Nonvascular plants

### Division Bryophyta

Liverworts, hornworts, and mosses make up this division of plants. These plants reproduce by means of spores and lack true leaves, stems, or roots. Most live in moist areas. However, some mosses can withstand severe temperatures and are found in Arctic or desert regions.

Liverwort (Hepaticae)

Hornwort (Anthocerotae)

#### Class Hepaticae

Liverworts make up this class. These small plants may be flat and ribbon-shaped or leafy. They grow close to the ground.

#### Class Anthocerotae

Hornworts usually grow only 1 to 2 centimetres across. The gametophyte is ribbonlike. Spores are contained in tubular sporangia that grow continuously from the sporangium base.

#### Class Musci

True mosses make up this class. Stems may be erect or horizontal and bear many leaflike growths. They seldom grow over 20 centimetres long.

Moss (Musci)

## Vascular plants

### Division Psilophyta

The plants in this division are called *whisk ferns* or *fork-ferns*. They have many slender, highly branched aerial stems. Some of the leaves may grow from underground stems. These rare plants are found in tropical and subtropical regions.

Whisk fern (Psilophyta)

**Division Lycophyta**

Club mosses, quillworts, and selaginellas are included in this division. The leaves of all of these plants have a single, central vein. Spores are produced in sporangia that grow in the leaf-stem nodes or on the leaves. During the Carboniferous Period, about 360 to 290 million years ago, some lycophytes were large trees. Today, these plants often grow in moist, shady areas on the forest floor.

Club moss (Lycophyta)

**Division Sphenophyta**

Horsetails are the only surviving plants of this division. These plants have small leaves that occur in whorls at the nodes on the stem. They grow 60 to 90 centimetres tall and reproduce by means of spores. During the Carboniferous Period, horsetails were tree-sized.

Horsetail (Sphenophyta)

**Division Pterophyta**

All the plants in this division are ferns. Their leaves are called *fronds*. Ferns differ widely in size and form. Some aquatic ferns have leaves only about 2.5 centimetres long. But some tropical tree ferns may reach heights of over 20 metres and have very large fronds. Ferns reproduce by means of spores.

Fern (Pterophyta)

**Division Coniferophyta**

Conifers make up this division of plants. Most are evergreen trees or shrubs with needlelike or scalelike leaves. Almost all conifers bear their seeds in woody cones.

Pine (Coniferophyta)

**Division Cycadophyta**

Cycads have fernlike leaves and large seed cones. The leaves of some species grow atop a tall stem. In others, the leaves grow from an underground stem.

Cycad (Cycadophyta)

**Division Ginkgophyta**

Ginkgoes are trees with fan-shaped leaves. They bear fleshy seeds at the ends of short branches. The seeds are not contained in cones. Only one living species exists today.

Ginkgo (Ginkgophyta)

**Division Gnetophyta**

Gnetophytes are a small group of unusual plants that grow in deserts and in tropical forests. They bear seeds that are surrounded by modified leaves called *bracts*.

Welwitschia (Gnetophyta)

**Division Anthophyta**

Flowering plants, or angiosperms, make up this division. All angiosperms have covered seeds. These plants have their sex cells in flowers. After fertilization, the ovary grows and encloses the seeds in a fruit. Angiosperms are divided into two classes—Monocotyledonae and Dicotyledonae.

**Class Monocotyledonae**

Monocots have seeds with only one *cotyledon* (seed leaf). The main veins in the leaves of these plants usually run parallel to each other. Flower parts usually occur in multiples of three.

**Class Dicotyledonae**

Dicots have seeds with two cotyledons. Their leaves have a complex system of veins. Their flower parts usually occur in multiples of four or five.

Iris (Monocotyledonae)

Wild geranium (Dicotyledonae)

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### Kinds of plants

Angiosperm
Annual
Biennial
Bryophyte
Conifer
Dicotyledon
Fern
Flower
Fungi
Grass
Gymnosperm
Herb
Hornwort
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Legume
Lichen
Liverwort
Monocotyledon
Moss
Mushroom
Perennial
Poisonous plant
Pteridophyte
Saprophyte
Shrub
Succulent
Tree
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### Parts of plants

Bark
Bud
Bulb
Catkin
Cell
Cellulose
Chlorophyll
Chloroplast
Corm
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Drupe
Flower
Fruit
Grain
Inflorescence
Leaf
Lenticel
Nut
Raceme
Rhizome
Root
Sap
Seed
Spore
Stem
Thorn
Tuber
Wood

### Plant diseases and pests

Aphid
Blight
Boll weevil
Brown-tail moth
Cankerworm
Codling moth
Cutworm
Damping-off
Dutch elm disease
Ergot
Fungal disease
Gall
Grain weevil
Gypsy moth
Japanese beetle
Leafhopper
Measuring worm
Mediterranean fruit fly
Mildew
Mosaic disease
Parasite
Peach moth
Phylloxera
Pink bollworm
Rose chafer
Rot
Rust
Scale insect
Smut
Tent caterpillar
Tussock moth
Viroid
Weevil
Wilt

### Plant products

Alcohol
Cork
Cotton
Drug
Dye
Fibre
Flax
Food
Forest products
Gutta-percha
Paper
Perfume
Resin
Rosin
Rubber
Tar
Timber
Tobacco
Turpentine
Veneer

### Plant growing

Agriculture
Alternation of generations
Auxin
Bonsai
Breeding
Farm and farming
Fertilizer
Gardening
Germination
Grafting
Greenhouse
Herbarium
Hybrid
Hydroponics
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Nursery
Photoperiodism
Photosynthesis
Pollen
Pruning
Reproduction (Plant reproduction)
Soil
Terrarium
Transplanting

### Where plants live

Bog
Desert
Forest
Grassland
Pampa
Pasture
Plain
Pond
Prairie
Savanna
Seashore
Steppe
Tropical rainforest
Tundra
Wetland

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Asia
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Oats
Peanut
Potato
Rice
Rye
Soybean
Sugar beet
Sugar cane
Tea
Tobacco
Wheat

### Flowers

Adonis
Aster
Aubretia
Begonia
Bindweed
Bird-of-paradise flower
Black-eyed Susan
Bluebell
Buttercup
Calceolaria
Calla
Campion
Candytuft
Canna
Canterbury bell
Christmas bells
Christmas bush
Chrysanthemum
Cineraria
Cockscomb
Columbine
Cornflower
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Crocus
Cyclamen
Daffodil
Dahlia
Daisy
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Day lily
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Easter lily
Flowering tobacco
Forget-me-not
Freesia
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Gladiolus
Godetia
Goldenrod
Greenhood
Groundsel
Gypsophila
Hawkweed
Hemlock
Hollyhock
Hyacinth
Iris
Jack-in-the-pulpit
Kangaroo paw
Larkspur
Lily
Lily of the valley
Lupin
Marigold
Mignonette
Monkey flower
Morning-glory
Mullein
Nasturtium
Orchid
Oxalis
Pansy
Peony
Petunia
Phlox
Pimpernel
Pink
Plantain
Poppy
Primrose
Pyrethrum
Ramp
Rose
Salvation Jane
Salvia
Saxifrage
Snapdragon
Spring beauty
Stock
Sturt's desert pea
Sunflower
Sweet alyssum
Sweet pea
Sweet William
Thistle
Thrift
Tiger lily
Toadflax
Tulip
Verbena
Violet
Zinnia

### Herbs

Balm
Basil
Bitters
Boneset
Calendula
Calla
Caraway
Catmint
Chervil
Chive
Cineraria
Coriander
Elecampane
Fennel
Figwort family
Ginseng
Horehound
Horseradish
Hyssop
Lavender
Marjoram
Mint
Parsley
Pennyroyal
Peppermint
Portulaca
Psyllium
Rosemary
Saffron
Sage
Spearmint
Spikenard
Sweet cicely
Tansy
Tarragon
Telegraph plant
Thyme
Valerian
Vanilla

### Vegetables

For a list of separate articles on vegetables, see the *Related articles* at the end of the Vegetable article.

### Shrubs and climbers

Acanthus
Alder
Arbutus
Azalea
Banksia
Bay
Bayberry
Beach plum
Blackthorn
Boronia
Bougainvillea
Box
Broom
Buckthorn
Camellia
Cassava
Cranberry
Dogwood
Elder
Eglantine
Forsythia
Furze
Gardenia
Grevillea
Hawthorn
Heather
Hebe
Hibiscus
Honeysuckle
Hydrangea
Jojoba
Laburnum
Lilac
Magnolia
Manzanita
Mock orange
Myrtle
Oleander
Passionflower
Plumbago
Privet
Pussy willow
Rhododendron
Saint-John's-wort
Spiraea
Sumach
Viburnum
Wattle
Wax myrtle
Wormwood
Yucca

### Trees

For a list of separate articles on trees, see the *Related articles* at the end of the Tree article.

### Other related articles

Balance of nature
Biological clock
Biome
Botanical garden
Conservation
Fossil
Nature study
Nitrogen cycle
Petrified forest

### Outline

**I. The importance of plants**
- A. Food
- B. Raw materials
- C. Medicines
- D. Plants and the cycle of nature

**II. Kinds of plants**
- A. Seed plants
- B. Ferns
- C. Lycophytes
- D. Horsetails
- E. Bryophytes

**III. Where plants live**
- A. The tundra
- B. Forests
- C. Grasslands
- D. Savannas
- E. Scrub
- F. Deserts
- G. Aquatic regions

**IV. Parts of plants**
- A. Roots
- B. Stems
- C. Leaves
- D. Flowers
- E. Seeds

**V. How plants reproduce**
- A. Sexual reproduction
- B. Vegetative propagation

**VI. How plants grow**
- A. Germination
- B. Water movement
- C. Photosynthesis
- D. Respiration
- E. Factors affecting plant growth

**VII. How plants change**
- A. Early plants
- B. Water storage
- C. Seed dispersal
- D. Insect-eating plants
- E. How people have changed plants

**VIII. Plant enemies**
- A. Diseases
- B. Nutrient deficiencies
- C. Pests
- D. How plants protect themselves
- E. Control of diseases and pests

**IX. Classification of plants**

### Questions

About how many kinds of plants are there?
How do animals help distribute seeds?
What are the four main parts of most flowering plants?
When did plants first appear on the land?
Describe the role of plants in the cycle of nature.
Why are flowering plants called *angiosperms*?
What is *cross-pollination*? What is *self-pollination*?
How do green plants make their own food?
What are the three major types of forests?
What are insectivorous plants?

**Plant, Aquatic.** See Water plant.

**Plant breeding.** See Breeding.

**Plant community.** See Ecology; Plant (Where plants live).

**Plant louse.** See Aphid.

**Plantagenet** was the family name of a line of kings that ruled England from 1154 to 1399. The kings descended from the marriage of Matilda, daughter of King Henry I, to Geoffrey, count of Anjou, France. Geoffrey was nicknamed *Plantagenet* because he wore a sprig of the broom *(genet)* plant in his cap. Many historians call these kings *Angevins,* meaning *from Anjou.*

The Plantagenet dynasty began with Henry II, son of Matilda and Geoffrey. Henry ruled from 1154 to 1189 over England and vast possessions in France. He centralized the English government, established peace and order, and founded the English common law system. His son, Richard the Lion-Heart, led the Third Crusade and ruled from 1189 to 1199. Richard's brother John succeeded him and ruled from 1199 to 1216. John lost most of England's French possessions. He was forced to grant the Magna Carta in 1215 (see **Magna Carta**).

John's son, Henry III, ruled ineffectively from 1216 to 1272. Henry's son, Edward I, ruled from 1272 to 1307, conquered Wales and most of Scotland, and improved the English government and legal system. Edward's son, Edward II, lost Scotland, was deposed by Parliament, and then murdered by barons in 1327. His son, Edward III, ruled from 1327 to 1377 and began the *Hundred Years' War* with France. After Edward III's grandson, Richard II, was deposed in 1399, the Plantagenets split into the houses of Lancaster and York. These two houses then ruled England until 1485 (see **Lancaster; York**).

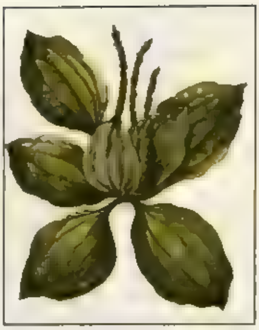
See also the separate biographies in *World Book* for each ruler mentioned, such as **Henry** (II) of England.

**Plantain** is the common name of a group of low-growing herbs, several of which are weeds. Plantains are widely distributed in the temperate zones and in mountainous regions of the tropics.

The *common plantain,* also called the *broad-leaf plantain,* is a species that often troubles gardeners. It may be recognized in spring by its circular cluster of broad light-green leaves that grow from the roots. Tall, slender spikes grow up from the centre of the cluster. In the summer, these spikes are thickly covered with tiny green flowers. Some plantains, such as the sea plantain, have medicinal uses.

The seeds of various plantains are used as a mild laxative.

A tropical plant called the plantain is a kind of banana. The fruit of this plant looks much like the banana although it is hard and starchy and is eaten cooked. The plantain's fruit has become one of the chief foods in tropical countries. A type of flour is made from the fruit of the plantain.



Common plantain

**Scientific classification.** Plantains belong to the plantain family, Plantaginaceae. The broad-leaf plantain is *Plantago major.* The banana-like plantain is *Musa paradisiaca.* The sea plantain is *P. maritima.*

See also **Banana** (introduction).

**Plantain lily.** See **Day lily.**

**Plantation** is a large land area where workers usually grow a single crop. The most common plantation crops are cocoa, coffee, rice, rubber, sugar cane, bananas, pineapple, and other kinds of tropical fruit. Most plantations are found in rich, level land areas in the tropical and subtropical regions of the world.

Plantations vary widely, depending largely upon their stage in development. Three separate types of plantations may be characterized as those that use slave labour, "free" labour, or skilled labour.

**Slave-labour plantations** were formed by western Europeans in the colonies they established throughout the world. The Europeans furnished money and management for plantation development and also the market for what was produced. Most of the plantation workers were slaves or *indentured servants* who were bound by contract to serve a landowner. They usually worked long hours in large gangs. They enjoyed few of the comforts of life. Plantation owners were the ruling class in society. Plantations were operated with slave labour in various parts of North and South America, and the West Indies from the colonial period until slavery was abolished during the 1800's. After that date, plantations in most of these countries used free labour.

**"Free"-labour plantations** came into use when slavery fell into disrepute. These large farming units produced single crops and paid low wages to hired hands. Labourers who worked for wages and *sharecroppers* (farmers who worked for a share of the crop) did most of the work. Various degrees of semislavery developed, including *peonage.* Peons are forced to work to pay off debts. Wage labourers worked in gangs and received wages. Wage labourers, peons, and sharecroppers frequently had an open account at the plantation *commissary* (supply store). The commissary often charged high prices. As a result, the workers would become indebted to the owner and would be forced to work off their debts. Such plantations still exist in parts of the world, and their owners form the ruling class in these regions.

**Skilled-labour plantations** are now developing in many areas. Sharecroppers and wage hands are disappearing. Since World War II (1939-1945), plantation agriculture has changed rapidly. Machines and skilled workers are now being used instead of mule power and hand labour. Labourers receive higher wages and live better than plantation workers did in earlier days.

See also **Colonial life in America** (picture: Southern plantation); **Slavery; United States, History of the** (picture: Cotton plantations).

**Planting.** See **Agriculture; Tree** (pictures: How to plant a tree).

**Plaque.** See **Teeth** (Cleaning the teeth; Periodontal diseases).

**Plasma,** in physics, is a form of matter composed of electrically charged atomic particles. The sun and the other stars, and most of the other objects in space, consist of plasma. Lightning bolts also consist of plasma.

Artificially created plasmas have many practical uses. For example, electricity turns the gas in the tube of a neon sign into a plasma that gives off light. A welding process called *arc welding* uses electricity to produce the high temperatures needed to join pieces of metal. Electric rockets may someday use plasma fuels for long trips through space.

A plasma can be made by heating a gas or by passing an electric current through it. A gas consists of atoms or molecules. Each atom has a nucleus surrounded by one or more negatively charged particles called electrons. Great heat or a flow of electricity *ionizes* an atom by stripping off one or more of its electrons. These electrons then move around independently. An atom or molecule that loses electrons has a positive charge and is called an *ion.* As the temperature increases, more and more atoms in a plasma become ionized.

The physical and electrical qualities of a gas change greatly when it becomes a plasma because the ions and electrons in the plasma are separated. For example, most gases conduct electricity poorly and are not affected by magnetic fields. A plasma, on the other hand, conducts electricity well and is affected by magnetic fields. Gases consist of atoms that move round independently and in no definite way. The electrons and ions in a plasma may move around in groups, usually in wave-like motions. Plasmas have qualities unlike those of the three basic forms of matter—gases, liquids, and solids. So physicists consider plasma a fourth state of matter.

Scientists hope someday to generate electricity by using plasmas to control the process of *nuclear fusion.* Nuclear fusion gives off tremendous amounts of energy when two lightweight atomic nuclei unite to form a heavier nucleus. The energy from controlled fusion could be used as heat to make steam for electric generators. But temperatures of up to 100,000,000° C are required to make the atomic nuclei react. Such a high temperature would melt any container. Many physicists are attempting to produce controlled fusion with hot plasmas held in place by strong magnetic fields.

See also **Nuclear energy** (Nuclear fusion); **Rocket** (Electric rockets); **Welding** (Arc welding).

**Plasma** is the liquid portion of blood. This yellowish, transparent fluid makes up more than half the volume of blood in the human body. The solid parts of blood—the red and white blood cells and the platelets—are suspended in the plasma. Plasma consists of more than 90 per cent water. A variety of dissolved substances, including proteins, salts, digested foods, and wastes, make up the rest of the plasma.

**Functions of plasma.** Plasma makes the blood fluid. Without this characteristic, blood could not perform its job of transporting vital substances throughout the body. Plasma carries blood cells and platelets to all parts of the body. It also transports digested foods to the body tissues. It picks up soluble waste materials from the tissues and carries them to the kidneys for excretion from the body. Plasma also transports hormones that help control the function and development of many parts of the body.

The three major types of plasma proteins—*albumin, globulins,* and *fibrinogen*—each serve important functions. Albumin (also spelled albumen) helps maintain a balance between the amount of fluid that leaves and enters the blood vessels. If plasma does not have enough albumin, excessive fluid passes through the blood vessels and accumulates in the tissues, causing the body to swell. In addition, albumin binds and carries nutrients absorbed from the digestive system.

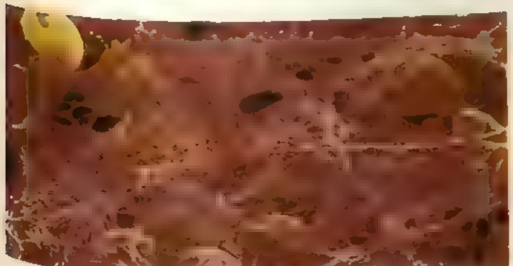
The globulins—particularly the *gamma globulins*—help protect the body from disease. Gamma globulins are *antibodies,* disease-fighting proteins that attack bacteria, viruses, poisons, and other harmful substances (see **Immune system**).

Fibrinogen is the most abundant of a group of plasma proteins called *clotting factors.* These proteins prevent excessive loss of blood from injured vessels. When a person starts bleeding, a chain reaction involving the clotting factors takes place. This reaction results in the formation of a blood clot.

**Uses in medicine.** Doctors use plasma for transfusions to provide clotting factors and other proteins. Plasma transfusions are used chiefly in the treatment of bleeding disorders. Because it contains most of the clotting factors, a transfusion of plasma can halt bleeding in many such cases. Plasma transfusions are also used to treat severe blood loss when whole blood is unavailable. Such transfusions have saved the lives of millions of accident victims.

Blood banks obtain proteins from plasma through a process called *fractionation.* Proteins obtained in this way include gamma globulins and individual clotting factors. Doctors sometimes use gamma globulins to protect against or modify such infectious diseases as measles and viral hepatitis. They use an individual clotting factor to control *haemophilia,* a bleeding disorder caused by an inherited deficiency or abnormality of a certain clotting factor.

Blood banks separate plasma from whole blood by allowing the solid components to settle by gravity or by using a machine called a *centrifuge.* A special donation technique called *plasmapheresis* removes only plasma, returning the blood cells and platelets to the donor. Blood banks freeze plasma for use in transfusions.



**The plasma protein fibrinogen** promotes clotting. When a blood vessel is injured, fibrinogen forms sticky threads, *above,* which hold cells together to prevent excessive blood loss.

**Plasma** is separated from whole blood by rotating bags of blood in a centrifuge. Then a laboratory technician, *above,* filters and separates the yellow plasma from the red blood.

See also **Blood; Blood transfusion; Serum.**

**Plassey, Battle of.** See **Clive, Robert.**

**Plaster** is a mortar coating that is applied to the inside wall surfaces and ceilings of buildings to make them more airtight and to provide a finished surface. Plastering is putting the plaster on these walls. When plaster is put on outside walls, it is called stuccoing (see **Stucco**).

Plasterers use a plaster that is made of sand and a cementing agent, such as gypsum, lime, or Portland cement. The ingredients are mixed with water. Hair or fibre is mixed with the first and second coats to strengthen the plaster. The hair is goat or cattle hair, and the fibre is Manila, jute, or wood fibre.

Lightweight materials such as *perlite* or *vermiculite* may be used instead of sand. These materials absorb sound and are fire resistant.

**Plaster bases.** Plaster can be put directly on a masonry wall, but it cannot be put directly on a solid wood wall. The surfaces to which plaster can be applied are called plaster bases. Bases may be of various kinds of building blocks, or brick or stone. Bases may also be made with *laths.* Laths are metal sheets, pieces of gypsum or fibreboard, or wooden strips that are put on the surface to be plastered to provide a better grip.

Wood laths are laid parallel, with narrow spaces between them. The plaster enters the spaces and forms wedges, called *keys.* The wedges hold the plaster to the laths. In most modern buildings, gypsum-board or metal laths are used. Metal laths are metal sheets about 0.5 metre wide and 2.5 metres long. Open spaces in the sheets allow plaster to penetrate and obtain a firm grip. Gypsum-board has a gypsum plaster core between surfaces of heavy paper. The paper and core are pressed together to form a plastering surface.

**A plasterer** applies the mortar coating in two or three coats to finish off the inside walls and ceilings of buildings.

**Plastering.** The plaster is put on the plaster base with a special tool called a *trowel.* It is smoothed with a tool called a *darby* and may be made more even with a long straightedge called a *rod.* Wood or metal strips, called *grounds,* are placed around openings and along the top of the baseboard as guides for finishing the plastering. If the plastered wall is large, plaster guides called *screeds* are made on the *scratch* (first) coat. Three coats of plaster should be used on wood or metal lath. But only two coats are needed on a brick or tile surface.

The surface finish of the plaster may be a *white coat* of lime putty, which has a thick, puttylike consistency when applied. Gypsum gauging plaster is added to it to reduce shrinkage and thus avoid cracking. The material is formed into a smooth finish with a steel trowel. The sand-float finish is a rough finish that is made by going over the last coat of gypsum plaster and sand with a special kind of wood or cork trowel, called the *float.* The sand-float finish looks like rough sandpaper. Special plasters may be applied in different ways to look like natural stones. The most common of these are *scagliola,* which is an imitation marble; imitation *caen* stone; and imitation *travertine* stone.

See also **Cement and concrete; Plaster of Paris.**

**Plaster of Paris** is a white powder that, when mixed with water to form a paste, will turn hard in a few minutes. This substance is used for casting small statuary, for surgical casts, and for many other purposes. It is made by heating gypsum, a stone composed of calcium sulphate and water. When the water is partly driven off, the gypsum softens and is easily crushed to form a powder. When water is added again, the mass hardens to a stonelike substance similar to the original gypsum.

See also **Gypsum.**

**Plastic explosive** is a puttylike explosive that can be hidden easily because it can be moulded into any shape. The explosive is made with a chemical code named RDX or a mixture of RDX and PETN, combined with a *plasticizer*—that is, a substance that makes the explosive flexible. Only a powerful detonator can set it off. Plastic explosives were used by Allied agents and resistance fighters in German-occupied countries during World War II (1939-1945).

The explosives became famous in the early 1960's when a French terrorist group, the Secret Army Organization (OAS), used them to try to prevent Algerian independence. Plastic explosives have remained a popular weapon among terrorists.

See also **Explosives** (High explosives).

**Plastic surgery** is a field of medicine that specializes in the repair or reshaping of defects of the body. It also may involve the repair of muscles, bones, blood vessels, and nerves. The word *plastic* comes from a Greek word meaning *to shape* or *mould.* Plastic surgeons shape and mould body tissues. They rearrange, remove, or replace tissue to restore normal function to deformed or damaged body parts. Plastic surgeons also attempt to improve the appearance of aging tissue.

**Methods of plastic surgery** include *grafting* (transferring tissue), repairing or reshaping tissue structures, removing tissue, and, less frequently, replacing tissue with an artificial substance. In grafting, a plastic surgeon replaces damaged tissue with healthy tissue from another area of the body. The surgeon may graft a single tissue—such as skin, a nerve, or bone—or a combination of tissues. In some cases, the surgeon must reconnect the transferred tissue to the circulatory system. Otherwise, blood will not circulate through the tissue adequately and the tissue will die. Grafting is used in treating such cases as severe burns, gunshot wounds, and injuries resulting from traffic accidents.

Injuries or diseases involving the loss of tissue or of a body part require the rebuilding or reshaping of tissue structures. Plastic surgeons may be able to reattach a severed body part. Often, however, the severed part is too severely damaged or has been without blood circulation for too long to permit repair. Congenital deformities, such as cleft lip, cleft palate, and birth defects of the face, ears, hands, and genitals, can be corrected by rebuilding and reshaping tissues. Similarly, a deformed or unattractive nose can be reconstructed and reshaped in an operation called a *rhinoplasty.*

Some plastic surgery done for cosmetic reasons involves the removal of tissue. A facelift operation, also known as a *rhytidectomy,* gives the patient a more youthful appearance by removing excess or aged facial skin. Plastic surgeons use a technique called *liposuction* to remove excess fat from such areas as hips, thighs, and ankles. In this procedure, an incision is made in the skin and then fat is suctioned out through a tube.

Plastic surgeons can reconstruct or alter the size or shape of a woman's breasts. This type of operation is called a *mammoplasty.* In a mammoplasty the surgeon inserts a synthetic implant into one or both breasts.

See also **Skin grafting.**

Strong, lightweight plastics make up the body of this van.

Durable polyester fabrics are made of plastic fibres.

Plastics are used to package a variety of items.

Plastics have special properties that allow them to be used in a wide variety of products. The photographs above illustrate some of the many uses of plastics.

# Plastics

**Plastics** are man-made materials that can be shaped into almost any form. They are one of the most useful materials ever created. Our homes, schools, and businesses are filled with plastic products. Engineers have developed plastics that are as rigid as steel or as soft as cotton. They can make plastics that are any colour of the rainbow—or as clear and colourless as crystal. Plastics can be rubbery or rigid, and they can be shaped into an endless variety of objects, ranging from car bumpers to squeezable bottles to soft fabrics. Plastic products, especially those used by industries, often have a useful life of many years.

Plastics consist of long chains of molecules called *polymers.* These chains are made of repeating patterns of smaller molecules. Each of the smaller molecules forms a "link" in the polymer's chain. In some plastics, the chains are rigid and are lined up like logs flowing down a river. In others, they are flexible and tangled like spaghetti on a plate. These different structures give plastics their most notable characteristic, the ability to be shaped. In fact, the word *plastics* comes from the Greek word *plastikos,* which means *able to be shaped.*

As useful as they are, plastics do have drawbacks. The biggest problem is that most plastics take a very long time to *decompose* (break down into simple compounds). Deciding how to dispose of plastic wastes has become a major environmental concern.

### How plastics are used

Engineers have created hundreds of different plastics, each with its own properties. They have developed plastics that can replace metals, natural fibres and hides, paper, wood and stone, and glass and ceramics. Manufacturers use these plastics to make products stronger, lighter, longer lasting, easier to maintain, or less expensive to make. In addition, inventors have used plastics to create items that could be made with no other materials.

**To replace metals.** Plastic parts are replacing metals in aeroplanes, cars, and many mechanical devices. Aeroplane manufacturers use plastic wing and body assemblies to reduce the weight of an aircraft, thereby reducing fuel consumption. Plastic car parts do not rust, nor do they dent as easily as metal ones. They are also easier and often less expensive to repair.

Plastics have also replaced metals in many building

construction materials, such as pipes and home cladding. Plastic cladding does not dent as easily as that made from aluminium. Pipes made from plastics are lightweight and easy to cut and join. Moreover, they do not corrode like metal pipes.

Surgeons mend broken bones with plastic parts rather than metal ones, because the plastics are less likely to trigger a harmful reaction. Dentists often use plastic fillings because—unlike metal fillings—the plastic ones can match the patient's tooth colour.

**To replace natural fibres and hides.** The textile industry uses plastics to replace such natural fibres as cotton, ramie, silk, and wool. Plastic fibres may have such qualities as strength, durability, and resistance to stains and wrinkling. Some plastic fibres are tough enough to be used for safety belts in cars or bulletproof vests. Others are delicate enough to be made into sheer hosiery. Durability and resistance to stains make plastic fibres excellent for clothing, carpeting, and furniture coverings. Manufacturers can also treat plastic fibres to make them more difficult to burn. Plastic fibres are often mixed with natural fibres to produce fabrics with qualities similar to an all-natural fabric but with added durability.

Plastics are also used to create synthetic leathers, suedes, and furs. Spun plastic fibres replace down or feathers in insulated jackets and pillows.

**To replace paper.** Plastics have replaced paper in many packaging applications. Plastic-foam packing materials provide more protection for boxed products than crushed paper does. Many fast-food restaurants use foamed plastic containers that help keep food warm.

Plastic wraps have many uses. They preserve foods longer than paper wraps can. Plastic wrap can stretch to form a seal around the opening of a container. Many items that are sold in cardboard packages, such as record albums, are sealed in clear plastic wrap.

**To replace wood and stone.** Plastics have replaced wood and stone in many applications. Laminated plastic worktops come in a variety of patterns. Some look like marble. Laminated worktops are lighter, less expensive, and easier to install than marble ones. They also resist marring and stains.

Furniture makers use plastics to produce cabinet doors and tabletops that look like wood but are easier to clean and do not warp. Plastics have also replaced wood in boat hulls. Plastic boats are stronger and require less maintenance. Unlike wooden hulls, plastic hulls can be constructed easily in one piece.

**To replace glass and ceramics.** Because they are lighter and far less likely to break, plastics have replaced glass or ceramics in a variety of products. Plastic wall tiles, baths, and sinks are cheaper and easier to install than ceramic ones. Aeroplane windows made of acrylic plastics are lighter and less brittle than glass. Plastic bottles are shatterproof, and they have replaced glass ones in packaging many foods and household goods.

**To provide new characteristics.** Plastics are used in many ways not possible for other materials. They have many medical applications because they are not harmful to the body and can be formed into any shape. Parts made from plastics can replace damaged hip, knee, and finger joints. Plastic pieces are used to rebuild facial structures damaged by accidents. Sometimes, plastic parts are used to replace faulty heart valves.

Plastics are also used to make insulating foam that blocks the flow of heat and sound. The foam can be blown into the walls of a home through a small hole. Integrated circuits, which hold thousands of transistors that control the flow of electricity, are sealed in plastics. The plastics protect the delicate transistors without interrupting the flow of electricity.

## Types of plastics

Although there are hundreds of different plastics, all of them belong to one of two basic types, based on how they behave when heated. These types are (1) thermosetting plastics and (2) thermoplastics.

*Thermosetting plastics*—or thermosets, for short—can be heated and set only once. They cannot be remelted or reshaped. When a thermoset is heated, it undergoes a chemical reaction called *crosslinking,* which binds its polymer chains together. This reaction is similar to the hardening of an egg when it is boiled. Once it has hardened, it cannot become a liquid again. Because thermosets cannot be remelted, engineers use them in applications that require high resistance to heat. Products made from thermosetting plastics include saucepan handles and trays for sterilizing medical instruments.

*Thermoplastics* can be melted and re-formed. Their polymer chains do not form crosslinks. Thus, the chains can move freely each time the plastics are heated.

Manufacturers use thermoplastics more than thermosets because thermoplastics are easier to handle. They also require less time to set—as little as 10 seconds, compared to as long as 5 minutes for thermosets. And unlike thermosets, most thermoplastics can be dispersed in liquids to produce durable, high-gloss paints and lacquers. Because their molecules can slide slowly past one another, some thermoplastics tend to lose their shape when exposed to constant pressure over a long period of time. For this reason, manufacturers prefer to use thermosets for such products as plastic seats.

## How plastics are made

The substances used to make plastic products are called *synthetic resins.* These resins are made primarily from petroleum, but some come from such other natural sources as coal, natural gas, cotton, and wood. Chemical manufacturers produce the resins and sell them to companies that make plastic products.

**The chemistry of plastics.** To understand how plastics are made, it is helpful to know something about the chemistry of polymers. The polymers in plastics are made up of small molecules called *monomers.* Most of these molecules are composed of carbon, hydrogen, nitrogen, and oxygen atoms. Some include chlorine, fluorine, silicon, or sulphur atoms. A polymer chain consists of hundreds, thousands, or even millions of monomer links. In some polymers, these links are made up of the same kind of monomer, repeated over and over again. Others are composed of two or more kinds of monomers, which may be linked randomly or in alternating sequences. In some polymers, blocks of one kind of monomer are joined to blocks of another kind.

Polymer chains may or may not have branches. A chain may have branches on only one side or alternating from one side to the other. The chains may pack together in straight rows to make a stiff, crystalline solid.

## Kinds of plastics

All plastics are classified as *thermosetting* or *thermoplastic*, depending on the way they act when heated. This table lists 20 common thermosetting and thermoplastic materials according to their chemical names. Each kind includes hundreds of compounds formed by adding chemicals to the basic material.

### Thermosetting materials

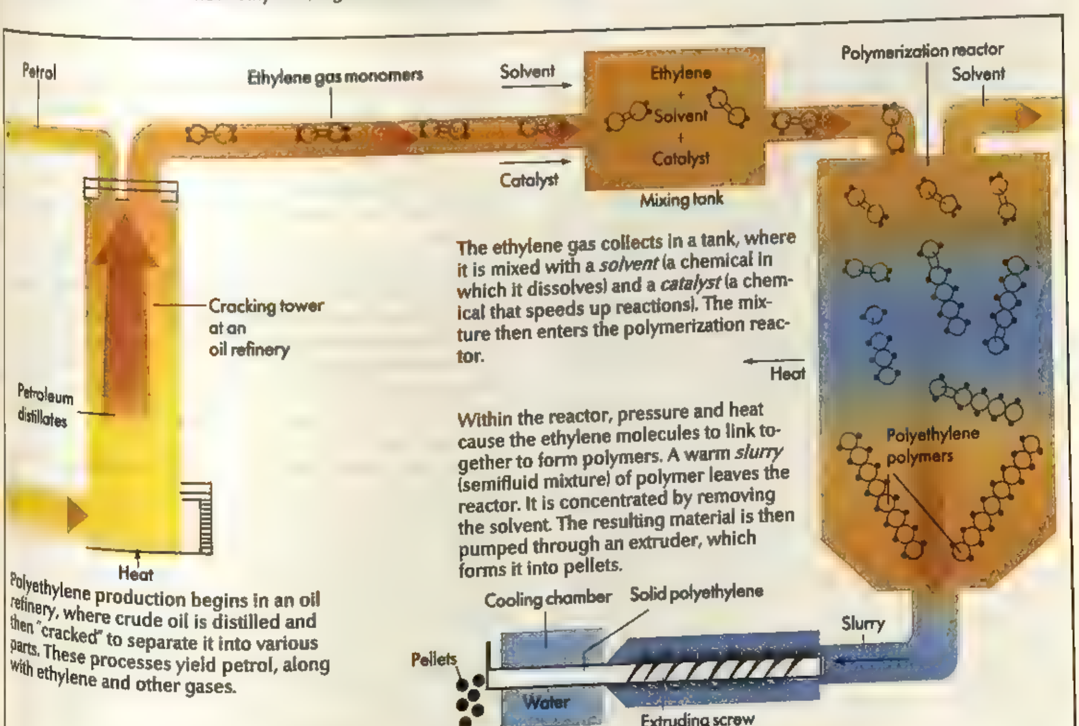
**Allylic:** strong, resists heat and weather. Used for electronics parts, coatings for moisture protection.
**Epoxy:** resists water and weather, hardens quickly, has high bonding strength. Used for adhesives, casting compounds, reinforced plastics, protective coatings, tools.
**Melamine- and urea-formaldehyde:** easily coloured, resists heat, odourless, tasteless. Used for tableware, lampshades, adhesives, buttons, tabletops, electrical parts, plywood binders.
**Phenolic:** resists heat and cold. Used for adhesives, appliance handles, electrical devices, surface coatings.
**Polyester:** strong, hardens quickly, moulds under low pressure. Used for boats, luggage, swimming pools, car bodies, chairs.
**Polyurethane:** tough, resists chemicals. Used for electrical insulation, structural parts, insulation foam, foam seat cushions, fabrics with elastic qualities.
**Silicone:** resists weather, has high elasticity and good electrical qualities. Used for oven gaskets, electrical insulation, greases and other lubricants, waterproof materials.

### Thermoplastic materials

**ABS (acrylonitrile-butadiene-styrene):** strong, long wearing, resists stains and chemicals. Used for telephones, wheels, handles, appliance parts, luggage, piping.
**Acetal:** tough, stiff, keeps its shape under pressure, has high melting point. Used for refrigerator and washing machine parts, cams, wheels.
**Acrylic:** resists weather and chemicals, easily coloured, has high clarity. Used for optical lenses, aeroplane canopies, signs, displays, car rear lights, fabrics, paints.
**Cellulose acetate:** tough, transparent. Used for toys, novelties, handles, packaging, photographic film, machine guards.
**Cellulose acetate butyrate:** tough, resists water. Used for steering wheels, pipes, tool handles, industrial parts.
**Nylon:** strong, springy, resists abrasion, has good electrical qualities. Used for fabrics, gears, bearings, hardware, brush bristles, electrical appliances, carpeting.
**Polycarbonate:** resists heat, has high impact strength. Used for business machine parts, electrical connectors, coil formers, light diffusers, windows, eyeglass safety lenses, aeroplane canopies.
**Polyethylene:** lightweight, flexible, has waxlike feel. Used for bottles, packaging, electrical insulation.
**Polypropylene:** lightweight, resists heat and chemicals. Used for rope, packaging, car parts, baby bottles, appliance parts, carpeting.
**Polystyrene:** lightweight, tasteless, odourless. Used for housewares, toys, electrical insulation, radio cabinets, packaging.
**Polytetrafluoroethylene (PTFE):** resists heat and chemicals, slides easily. Used for cable insulation, bearings, valve seats, gaskets, saucepan coatings, slides and cams.
**Polyvinyl chloride (PVC):** strong, easily coloured, rigid or flexible, resists abrasion. Used for imitation leather, records, packaging, pipes, electrical insulation, floor covering.
**Polyvinylidene chloride:** crystal clear, tough. Used for packages for meat and other foods.

## How plastic resins are made

Plastic resins are made primarily from chemicals that come from petroleum. This diagram shows how ethylene, a gas derived from petroleum, is polymerized to form polyethylene plastic resins.



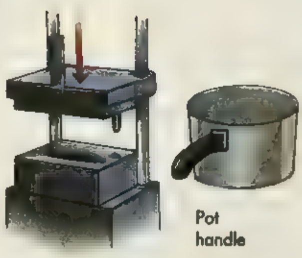

Polyethylene production begins in an oil refinery, where crude oil is distilled and then "cracked" to separate it into various parts. These processes yield petrol, along with ethylene and other gases.

The ethylene gas collects in a tank, where it is mixed with a *solvent* (a chemical in which it dissolves) and a *catalyst* (a chemical that speeds up reactions). The mixture then enters the polymerization reactor.

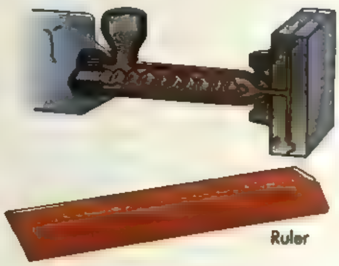
Within the reactor, pressure and heat cause the ethylene molecules to link together to form polymers. A warm *slurry* (semifluid mixture) of polymer leaves the reactor. It is concentrated by removing the solvent. The resulting material is then pumped through an extruder, which forms it into pellets.

**How plastic products are made**

Manufacturers make plastic products from plastic resins, which melt into a syrupy liquid when heated. The products are shaped by several methods, as shown in these illustrations.

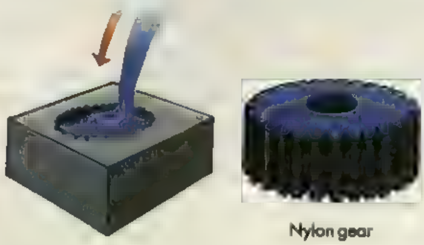



**Compression moulding** uses heat and pressure to shape plastics. The process is commonly used to mould thermosetting plastics.

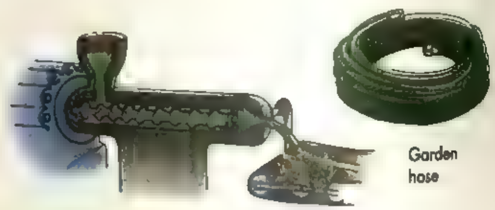



**Injection moulding** shoots molten plastic material under pressure into a mould. It is the most widely used method of moulding thermoplastics.


**Blow moulding** produces hollow objects. It uses air or steam to expand a tube of molten resin, forcing the material against a mould's walls.




**Casting** does not depend on any external pressure to shape the plastics. In the casting process, melted resin is simply poured into a mould. Manufacturers use casting to produce thick, solid objects.




**Extrusion** is used to produce such continuous forms as pipes, rods, fibres, and wire coatings. Rotating screws force the plastics through a heated barrel, in which they melt, then force them out through a specially shaped die.

Or they may remain tangled and spread out, to make a soft, rubbery material. The properties of plastics depend on the types of monomers in their polymer chains, the lengths of the chains, and the arrangement of the chains.

Different kinds of polymer molecules can be mixed together to form *polymeric alloys,* or *blends.* Alloys are often easier to create than new synthetic polymers. They may have properties that lie between those of their component polymers, or they may have properties that are better than either. Polymer scientists can engineer blends of plastics with the ideal properties for nearly any task. Alloys are used in products that range from packaging films to car body parts.

**Making synthetic resins.** Resin manufacturers make polymers by combining chemical compounds. These range from familiar chemicals like ammonia and benzene to compounds with tongue-twisting names such as hexamethylenediamine. When a manufacturer combines appropriate compounds, chemical reactions cause atoms to cluster together to form monomers. Further reactions cause the monomers to *polymerize*—that is, to form long chains of molecules. Polymerization produces the synthetic resin.

Manufacturers frequently use *additives* to change the properties of a plastics resin. Common additives include (1) reinforcements, (2) fillers, (3) plasticizers, and (4) pigments.

Resin manufacturers use such reinforcements as glass fibres or carbon fibres to give plastics extra strength or rigidity. The resulting mix, called a *composite* or a *reinforced plastic,* may contain from 10 to as much as 80 per cent reinforcement. Composites are lightweight and can replace metals in missiles, aircraft, and cars.

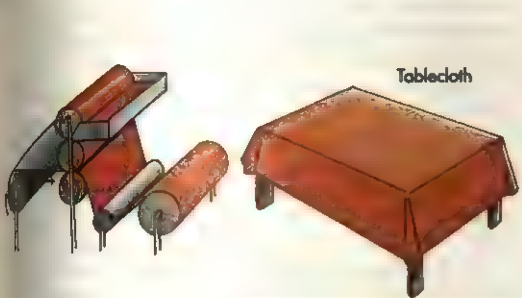
Resin manufacturers may use fillers to improve the quality of plastics or to extend an expensive resin. Common fillers include powdered wood, talc, and clay.

Manufacturers add plasticizers to certain synthetic resins to make them softer, more flexible, and easier to shape. Plasticizers overcome the attractive forces between the polymer chains and separate them to prevent intermeshing.

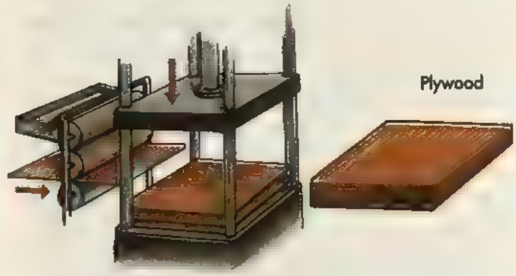
Pigments change the colour of plastics. Resin makers use pigments to produce unlimited varieties of colour.

Additives enable resin manufacturers to make plastics even more useful. For example, vinyl plastics are naturally clear and rigid. But thanks to additives, vinyl plastics can be made into products ranging from rigid, grey pipes to slightly flexible, black records to soft, transparent windows for car roofs.

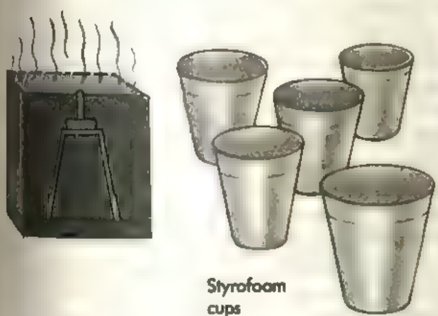
**Making plastic products** involves seven main processes to shape plastics into products. They are (1) moulding, (2) casting, (3) extrusion, (4) calendering, (5) laminating, (6) foaming, and (7) thermoforming.




**Calendering** produces plastic sheets by pressing molten plastic material between two rollers. Manufacturers also feed fabric, paper, or other materials through the rollers to produce such items as tablecloths and playing cards.




**Laminating** involves coating sheets of such materials as wood, paper, or metal foil with plastics. The sheets are then stacked and pressed together to make such products as plywood, electronic circuit boards, and tabletops.




**Foaming** is any of several methods that produce solid plastics filled with air spaces. To make styrofoam, for example, manufacturers use beads of thermoplastic resin containing a chemical that forms a gas when heated during moulding.


**Thermoforming** is used to mould items from sheets of plastics. A sheet is clamped over a mould and heated until it becomes soft. A vacuum pump sucks air out through tiny holes in the mould, drawing the sheet into the mould.

***Moulding.*** There are a variety of moulding processes, including compression, injection, blow, and rotational moulding. In all these processes, force is applied to the plastic material during and after it enters the mould. Once the product has hardened, it is released from the mould. The mould can then be reused.

Compression moulding is the most common method of moulding thermosets. Compression-moulded products include car bumpers, electrical switches, and handles for cooking utensils and irons. In compression moulding, resin powder is put into a mould. The manufacturer then heats the mould and, at the same time, applies pressure. After the plastics have set, the mould is opened and the product is released.

Injection moulding is the most widely used method of moulding thermoplastics. Injection-moulded products include telephones, computer housings, and car steering wheels. In injection moulding, resin pellets fall from a hopper into a heated, horizontal barrel, where they melt. A plunger or revolving screw inside the barrel pushes the liquid resin under pressure into a mould. Most injection-moulded products take only 10 to 30 seconds to harden. The mould is opened, and ejector pins push the formed product out of the mould. The mould is then closed and refilled.

Blow moulding is used to make bottles and other hollow objects. In this process, a tube of molten resin, called a *parison,* is inserted into a mould. Compressed air or steam then is forced into the parison, which expands, forcing the resin against the walls of the mould, where it is held until it hardens.

Rotational moulding also forms hollow objects, such as soccer balls, dolls, and car fuel tanks. In this process, a mould is partly filled with powdered resin. The mould is then heated while a motor spins it rapidly, creating a centrifugal force. This force pushes the melting resin against the mould walls and holds it there as the mould is cooled and the object solidifies.

***Casting,*** unlike moulding, does not depend on any external pressure to shape the plastics. Manufacturers use this method to shape both thermoplastics and thermosetting plastics. To cast thermosets, they pour a liquid resin containing chemicals into a mould and harden it by applying heat. For thermoplastics, the molten resin is poured into a mould and cooled until it sets. Processors employ casting to make thick plastic panels and to produce gears, paperweights, and other solid objects.

***Extrusion*** is used to produce pipes, rods, fibres, wire coatings, and other products that have the same shape along their entire length. Solid thermoplastics particles from a hopper enter a stationary, heated barrel. One or more rotating screws force the particles through the barrel, where they melt as they are pushed along. The molten material is forced out through a shaping die.

*Calendering* produces a continuous plastic sheet or film by pressing molten plastics between pairs of polished, heated rollers. Manufacturers feed fabric, paper, or metal foil through the rollers to produce such items as plastic-coated playing cards and tablecloths.

*Laminating* uses plastics to bind together stacks of fibreglass, wood, paper, cloth, or metal-foil sheets. The sheets are coated or soaked with a resin. They are then placed one on top of the other. A machine squeezes the sheets together and heats them until the resin has joined them firmly. Laminating produces strong materials with a wide range of thicknesses for various products. These products include plywood, electronic circuit boards, and tabletops.

*Foaming* refers to any of several methods that produce plastic foams. All these methods involve introducing a gas into heated plastic resins. The gas expands and creates bubbles in the cooling resin. The resulting material is lightweight plastic foam, which is sometimes called *cellular plastic*. Depending on the resins and the method, plastic foams can be stiff and strong, such as those used in home insulation and fast-food packaging. Others can be soft and rubbery, such as the foams in furniture cushions and pillows.

*Thermoforming* is an inexpensive process used to mould items from sheets of plastics. In this process, workers clamp a plastic sheet over a mould. They then heat the sheet until it becomes soft. Next, a pump sucks air out through tiny holes in the mould. This creates a vacuum that pulls the soft plastic sheet down until it covers the surface of the mould. There it cools and hardens in the shape of the mould. Manufacturers use thermoforming to produce such objects as baths, shower bases, and yoghurt containers.

### Development of plastics

For thousands of years, people used natural gums and resins with properties similar to plastics. For example, the ancient Greeks and Romans created decorative objects from *amber*, a fossil resin. During the Middle Ages, Europeans used the natural resin *lac*, and its purified form, *shellac*, to coat objects (see **Lac**).

By the mid-1800's, the commercial moulding of plasticslike natural substances had developed. Manufacturers moulded items from lac, *gutta-percha* (a tree resin), and other substances obtained from animal, vegetable, and mineral sources (see **Gutta-percha**). Products made from these natural "plastics" included brush handles, knobs, electrical insulation, records, and novelty items.

Despite their beauty, these natural moulding materials had several disadvantages. Manufacturers often had difficulty obtaining the raw materials. Some materials proved difficult to mould, and many of the finished products turned brittle and broke easily.

**The invention of Celluloid.** In the late 1860's, John W. Hyatt, a printer from Albany, New York, U.S.A., developed a material to replace the scarce ivory used to make billiard balls. In 1870, he and his brother Isaiah received a patent for the material, which they later named *Celluloid*. Celluloid was the first synthetic plastic material to receive wide commercial use.

Hyatt made Celluloid by first treating *cellulose*, a substance found in cotton, with nitric acid. He then combined the resulting substance, *pyroxylin*, with the solvent *camphor*. The end product, Celluloid, was a hard, stiff material that could be shaped under heat and pressure to form useful items.

Celluloid was used for years to make such products as combs, dentures, and photographic films. But it was highly flammable. During the early 1900's, researchers produced a similar, but less flammable, material called *cellulose acetate*. Today, manufacturers use cellulose acetate to make films, fibres, and moulded objects. Celluloid itself is still used to make ping-pong balls.

**The invention of Bakelite.** During the early 1900's, Leo Baekeland, a chemist from New York City, tried to make a synthetic shellac by combining the chemicals carbolic acid (also known as phenol) and formaldehyde. Chemists had experimented with combining these chemicals for several years, but the reaction had been too violent to contain. Baekeland succeeded in controlling the reaction, which created *phenolic resin*.

The resin was not the synthetic shellac that Baekeland had sought but rather the first of the thermosetting plastics. He patented it in 1909 and named it *Bakelite*, after his own name. Bakelite soon became widely used to make such items as telephones and handles for pots and irons. It continues to be used today in the some electrical appliances and cars.

**Growth of the plastics industry.** The introduction of Bakelite in 1909 gave scientists a better understanding of polymer chemistry. The plastics industry expanded steadily throughout the next three decades.

The most dramatic developments occurred in the 1930's. Four important thermoplastics—acrylics, nylon, polystyrene, and polyvinyl chloride (PVC or vinyl)—came into commercial use. Acrylics are strong and clear. They became widely used for aeroplane windows. Nylon was used to make women's hosiery and, later, such moulded products as bearings and gears. Manufacturers used polystyrene in many products, including clock and radio housings, toys, wall tiles, and food containers. PVC was used in such diverse products as garden hoses, raincoats, wire insulation, and electric plugs. The introduction of specialized machinery to form and mould plastics into useful items also helped the growth of the industry.

Important thermosetting plastics called polyesters were introduced commercially in the 1940's. Important thermoplastics developed during the 1940's included polyethylene, silicones, and epoxy resins. All of these plastics found new uses during the early 1950's. Polyethylene proved an excellent material for plates, squeezable bottles, plastic bags, and other products. Manufacturers used silicones in lubricants and electrical insulation, and surgeons used them in body implants. Epoxy resins gained wide use as strong adhesives. Manufacturers used polyesters to make boat hulls and car bodies.

The uses of plastics continued to grow during the late 1950's and the 1960's. This growth corresponded directly to the growth of the petrochemical industry, the major producer of the raw materials for plastics. Engineers found new uses for plastics in medicine, nuclear and space research, industry, and architecture. Polymer chemists developed several new plastics that are especially resistant to chemicals and extreme heat.

Throughout the 1970's and 1980's, plastics continued to find new applications, appearing in such products as microwave cookware, personal computer housings, and compact discs. Aerospace engineers used heat-resistant polyurethane foam to cover the external fuel tanks of the United States space shuttles. This plastic foam acts as heat insulation to prevent loss of fuel by evaporation. During the late 1980's, scientists developed the first practical *conductive plastics*, which—unlike other plastics—can carry an electric current. Conductive plastics have possible uses in batteries, wiring, and static-resistant fabrics.

### The plastics industry

The United States, Japan, and other industrial nations lead the world in plastics production. The plastics industry continues to grow rapidly in these countries. The growth of the industry in any country depends on a plentiful supply of petroleum.

Plastics companies may be divided into three general groups: *resin manufacturers* (mostly chemical companies) who make and supply resins; *processors* who shape the resins into products; and *finishers and assemblers* who make products by cutting, drilling, decorating, and assembling plastic parts. Most resin manufacturers are located in regions that allow easy access to great supplies of petroleum. Most processors, finishers, and assemblers operate in areas where they can serve many industries.

### Plastics and the environment

As more and more plastic packaging materials are used by consumers, more plastic waste is generated. Because most plastics do not readily break down, this waste contributes significantly to environmental pollution.

Recycling has emerged as one method of combating the problem of plastics waste. Industries that produce or use large amounts of plastics have recycled their wastes for years. Usually they clean and separate the plastics by type. They recycle the thermoplastics by remelting and re-forming them into new products. Thermosets are either ground into fine powders or shredded. The powders are used as fillers. The shreds can be used as insulation in such products as quilted jackets and sleeping bags.

In the 1980's, some cities and towns turned to recycling to help dispose of consumer plastics waste. These communities require citizens to sort certain plastic items—such as polyester soft drink bottles—from other waste materials. These plastics can be reused in the same manner as industrial plastics waste.

Some communities do not separate the plastics but instead burn the mixed municipal waste. This process yields energy that can be used for electricity or heating. It requires, however, sophisticated incinerators that remove the acid gases produced by the burning of PVC and other plastics.

Another approach to the disposal problem is to design plastics that decompose or break down naturally in the environment. In the 1970's, chemists introduced *biodegradable* plastics that break down through the actions of microorganisms. In products made from these plastics, molecules of starches or cellulose separate the polymer chains of the plastics. Microorganisms attack and consume the starches and then cause the products to deteriorate. Scientists also developed *photodegradable* plastics that break down through long exposure to sunlight. The polymers in these plastics are decomposed by a chemical additive that breaks down when the material is exposed to sunlight.

In the mid-1980's, manufacturers began using degradable plastics to make rubbish-container bags, foam cups, and other disposable products. But such plastics have been criticized by environmental groups and even members of the plastics industry. These critics argue that even under the best conditions, degradable plastics products leave residues behind, and that the products will not break down at all when buried in landfills away from the action of sunlight or bacteria. They are also concerned that the additives that cause plastics to degrade also make the plastics unfit for recycling, which is a better way to conserve resources.

**Related articles** in *World Book* include:

Acrylic
Bottle
Cast and casting
Cellophane
Die and diemaking
Environmental pollution (Technological causes)
Extrusion
Fibre
Fibreglass
Glass (Speciality glasses)
Laminating
Nylon
Petrochemicals
Polarized light
Polyester
Polymerization
Resin, Synthetic
Silicone
Strength of materials
Styrofoam
Synthetics
Theatre (Costumes and makeup)
Vinyl

**Outline**

I. **How plastics are used**
   A. To replace metals
   B. To replace natural fibres and hides
   C. To replace paper
   D. To replace wood and stone
   E. To replace glass and ceramics
   F. To provide new characteristics
II. **Types of plastics**
III. **How plastics are made**
   A. The chemistry of plastics
   B. Making synthetic resins
   C. Making plastic products
IV. **Development of plastics**
   A. The invention of Celluloid
   B. The invention of Bakelite
   C. Growth of the plastics industry
V. **The plastics industry**
VI. **Plastics and the environment**

**Questions**

What are the leading plastics-producing countries?
What are some metal products that plastics can replace?
How does casting differ from moulding?
What is a *filler*? A *plasticizer*?
How do thermoplastics differ from thermosetting plastics?
What is the chief source of chemicals for the production of synthetic plastics?
What was the first synthetic plastic material to receive wide commercial use?
What is a polymer?
What are some methods for controlling plastic waste?
What types of new applications did plastics find during the 1970's and 1980's?

**Plata, Río de La.** See Río de la Plata.

**Plate tectonics** is a theory that explains the origin of most of the major physical features of the earth's surface. For example, the theory tells us why most volcanoes occur where they do, why there are high ridges and deep trenches in the oceans, and how mountain ranges form.

According to this theory, the earth has an outer shell made up of about 30 rigid pieces called *tectonic plates.* Some of these plates are gigantic. For instance, most of the Pacific Ocean covers a single plate. Other plates, such as the Fiji plate, are relatively small.

The plates move about on a layer of rock that is so hot it flows, even though it remains solid. The plates are moving very slowly relative to one another. They move at speeds up to about 10 centimetres per year.

Plates have been moving about for hundreds of millions of years. So, in spite of their very low speeds, some of them have moved vast distances. In fact, over the past several hundred million years, plate movement has changed the map of the earth drastically. Earth scientists have determined that before about 200 million years ago, all the continents were part of a supercontinent called *Pangaea.*

## Structure of tectonic plates

Tectonic plates are made up of the earth's *crust* and the outermost part of its *mantle.* The crust is the outermost layer of the earth. It is thin and rocky. All the dry land, all the ocean floors, and the beds of all the other bodies of water on earth are part of the crust. The mantle is a thick layer of hot rock under the crust and above the *core,* a dense sphere at the earth's centre. See **Earth** (illustration: Inside the earth).

The continents are embedded in the tops of plates, so as these plates move, they carry the continents along with them. The plates that carry continents do not have the same boundaries as their continents; they include both continents and ocean floor.

Plates are typically about 100 kilometres thick. However, they may be less than 8 kilometres thick at certain places in the oceans and as much as 200 kilometres thick under parts of continents.

The plates as a whole make up the earth's *lithosphere.* The layer of mantle rock under the plates is the *asthenosphere.* This rock reaches temperatures between about 1300 °C and 2000 °C.

## Plate interactions

As the tectonic plates move about on the asthenosphere, they interact with one another at their boundaries. There are three types of boundaries: (1) *divergent,* where plates move apart from each other, (2) *convergent,* where plates move toward each other, and (3) *transform,* where plates slide alongside each other.

**Divergent plate boundaries** are mostly on ocean floors. There, the separation of plates, or *rifting,* creates lithosphere. Rifting on continents creates gaps into which water flows to form major river systems, lakes, and even oceans.

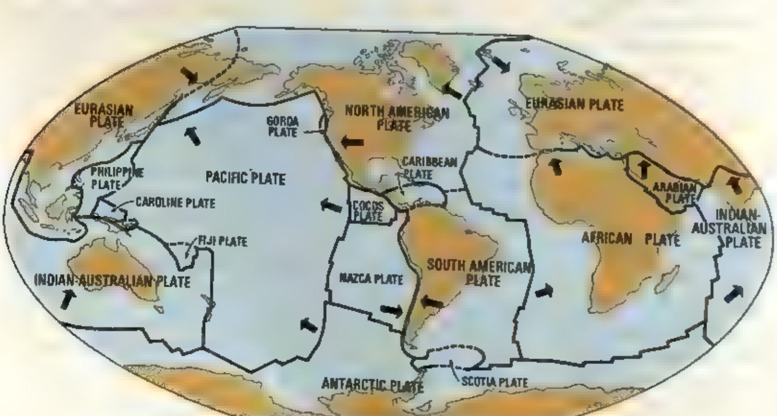
***The rifting of the ocean floor*** enlarges the floor. *Magma* (liquefied rock) rises from the asthenosphere, filling the gap between the separating plates. The magma hardens, creating equal amounts of new crust on the edges of the two plates. The process of separation of plates and formation of new crust is called *seafloor spreading.* This process creates about 2.4 square kilometres of ocean crust a year.

The build-up of ocean crust on plate boundaries generates long underwater mountain ranges called *ocean ridges.* Some of these mountain ranges occur along the centre of ocean basins and are called *mid-ocean ridges.* One such mid-ocean ridge, called the *Mid-Atlantic Ridge,* extends from waters east of Newfoundland in Canada to an area off the southern tip of South America. See **Ocean** (map: The land beneath the oceans).

Earthquakes occur at ocean ridges when one plate edge drops down and grinds against the edge of a neighbouring plate. These earthquakes occur a short distance beneath the surface of the plates, indicating that newly formed plate edges are very thin. See **Earthquake** (Ocean spreading ridges).

***The rifting of continents*** creates new seas as ocean waters fill a gap in continental crust. The Red Sea region, for example, is in an advanced stage of rifting. The rift is already flooded by ocean waters—the Red Sea, an extension of the Indian Ocean.

The East African Rift, a unit of the Great Rift Valley that extends from Ethiopia to Mozambique and connects to the Red Sea, is in an early stage of rifting. There, the gap is not yet deep enough to become filled with ocean water from the Indian Ocean.




**Earth's tectonic plates**

The earth has a rigid outer shell broken up into large slabs of rock called *tectonic plates.* Many of these plates, *left,* include both ocean floor and dry land. Some plates have entire continents embedded in their tops. The plates move slowly about on molten rock underneath the shell. *Arrows* indicate the directions in which some of the largest plates move.

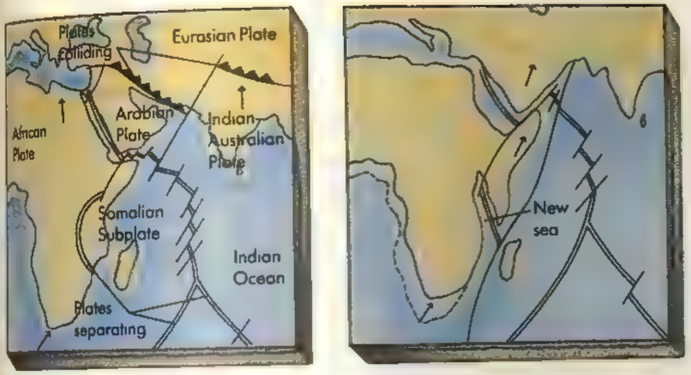
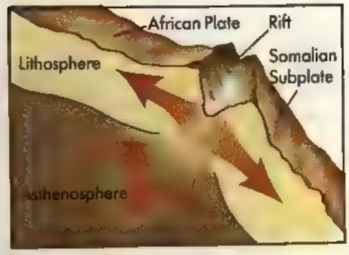



**Plate movements** are reshaping Africa. The African Plate, in which most of the continent is embedded, is moving north and northeast, *above left,* while the small Somalian Subplate is separating from the African Plate. If these movements continue for 50 million years, *above right,* a new sea will open up along the eastern coast of Africa.




**A rift** has already formed in eastern Africa, where molten rock of the asthenosphere is rising, pushing apart tectonic plates of the lithosphere. In time, a sea will form along Africa's eastern coast.

**Convergent plate boundaries** are places where lithosphere created at divergent boundaries is destroyed by recycling into the mantle. At a convergent boundary, the edge of a plate sinks, thrusting under the margin of its neighbouring plate. This process is called *subduction.* The sinking plate can create deep ocean trenches where it plunges into the asthenosphere. Because the earth is not changing in size, scientists believe that *subduction zones* consume the same amount of ocean crust as ocean ridges create.

The subducting plates generate powerful earthquakes and usually create a line of volcanoes along the overriding plate boundary. A volcano forms when magma, hot gases, and fragments of rock burst through the surface. Subduction zones generate magma at a depth of about 120 kilometres by melting three kinds of material: oceanic crust at the top of the descending plate, ocean sediment dragged to great depths, and asthenosphere caught in the corner between the converging plates.

At some convergent plate margins, the overriding plate scrapes a thick mass of sediment off the descending plate. This process of *subduction accretion* adds material to the edge of the overriding plate. In California, for example, subduction accretion formed a large part of the coastal mountain ranges.

At other convergent plate boundaries, the edge of the descending plate, all its cover of sediment, and even pieces from the edge of the overriding plate disappear beneath the overriding plate. This process, *subduction erosion,* causes continents to shrink. Such erosion is occurring in the Pacific Ocean along the coasts of Peru and Chile and east of the Mariana Islands.

At boundaries where plates carrying continents collide, layers of rock in the overriding plate crumple and fold like a tablecloth that is pushed across a table. About 40 million years ago, a plate that includes what is now India collided with the southern edge of the Eurasian Plate, which includes Europe and most of Asia. The Indian-Australian Plate began to push beneath the Eurasian Plate, causing rock in the Eurasian Plate to crumple and fold. Over millions of years, folding of rock in the Eurasian Plate formed the Himalaya, the world's highest mountain system.

**Transform plate boundaries,** where plates slide horizontally against each other, neither create nor destroy lithosphere. However, at these boundaries, or *transform faults,* powerful earthquakes can occur. For example, devastating earthquakes have occurred in California in the United States along parts of a transform plate boundary known as the San Andreas Fault.

The San Andreas Fault forms part of the boundary between two large plates—the North American Plate and the Pacific Plate. The fault connects a spreading ridge in the Gulf of California to a trench off the coast of northern California. The parts west of the fault are attached to the Pacific Plate and are moving northwest. See **San Andreas Fault.**

### Plate movement

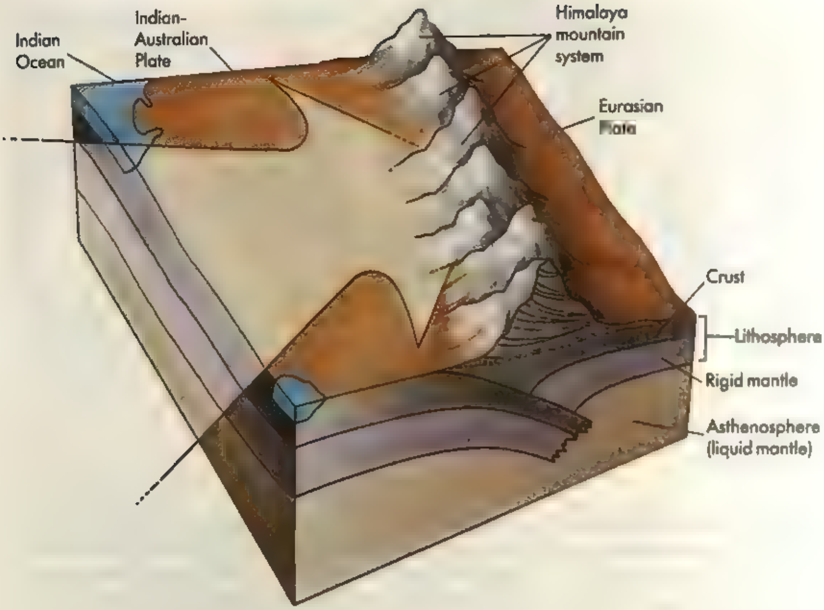
**Rate.** Earth scientists measure the speed of plate movement by monitoring how rapidly a plate moves relative to the plate next to it. Today, plates move about 10 centimetres a year—about as rapidly as human hair grows. In the past, plates may have moved as fast as 16 centimetres per year.

**The overall pattern** of movement of the tectonic plates is a widening of the Atlantic Ocean and a shrinkage of the Pacific Ocean. The Atlantic is widening because sea-floor spreading at the Mid-Atlantic Ridge continues to create lithosphere. The Pacific is shrinking because much of it is ringed by convergent plate boundaries that are consuming its lithosphere.

Scientists have traced the movements of tectonic plates millions of years into the past. According to the commonly accepted description of plate movement, all the continents once formed part of an enormous single land mass called Pangaea. This mass was surrounded by a giant ocean known as *Panthalassa.*

About 200 million years ago, Pangaea began to break up into two large masses called *Gondwanaland* and *Laurasia.* These masses, in turn, broke up into the continents, which drifted to their present locations.

**Evidence of plate movement.** Earth scientists find much evidence of plate movement at the boundaries of plates. They study surface features, such as mountains and ocean trenches, and investigate the frequencies and locations of earthquakes and volcanic eruptions.




**The Himalaya,** the world's highest mountain system, is a result of the collision of two huge tectonic plates about 40 million years ago. The Indian-Australian Plate struck the Eurasian Plate and began to plunge beneath it. Layers of rock in the Eurasian Plate folded like a tablecloth that is pushed across a table, forming the Himalaya. Today, the Indian-Australian Plate continues to push against the Eurasian Plate.

Volcanoes that rise within plates are also evidence of plate movement. Scientists believe that these volcanoes are caused by *mantle plumes,* columns of very hot mantle that rise from deep inside the earth to the base of the lithosphere. These plumes generate magma that rises through the lithosphere and erupts in places called *hot spots.*

As a plate moves over a hot spot, the spot can generate a chain of volcanoes. For example, a hot spot under the Pacific Plate generated volcanoes that became the Hawaiian islands.

*Palaeomagnetism* (the study of magnetism in ancient rocks) also provides evidence of plate movement. The evidence is in rocks that contain magnetic particles.

When such a rock was hot and liquid, the magnetic particles were free to align themselves with the earth's magnetic field, like tiny compass needles. Once the rock has cooled and solidified, however, the earth's magnetic field can no longer influence the direction in which the magnetized particles point. Thus, the particles continue to point in the direction of the magnetic field that was present when the rock cooled.

So when the plate containing the rock either drifts to a different latitude or rotates, the particles no longer align with the earth's magnetic field. A comparison of the direction in which the particles now point in the rock with the direction of the earth's present magnetic field provides information about where the plate was when the rock solidified. For example, studies indicate that Europe and North America were once connected.

**Causes of plate movement.** Tectonic plates slide mostly because of temperature changes and gravity. As an edge that has formed on the ocean floor cools, it shrinks, becoming denser. After about 25 million years of cooling and shrinking, the edge becomes so dense that gravity can pull it down into the asthenosphere. There, the intense heat and increased pressure due to the great depth, change the crust of the sunken plate edge into even denser rock. Because of the additional density, gravity pulls the plate edge into the asthenosphere even more strongly.

This sinking action is known as *slab-pull* because the sinking edge pulls the remainder of the slablike plate behind it. Many scientists believe that slab-pull is the main action driving the motion of plates with sinking edges.

Gravity also causes plates to slide downhill away from ocean ridges. This sliding force is called *ridge-push.*

Another cause of plate movement is the simple pushing of plates against one another. Scientists believe that large plates shove some small plates about.

The rise of mantle plumes and other movements of mantle rock may also affect the motion of tectonic plates slightly. The circulation of mantle rock as it rises to the top of the asthenosphere, cools, and then sinks is known as a *convection current.*

Earth scientists once thought that convection currents caused continental drift. Today, however, most earth scientists believe that such currents are primarily a result of the sinking of plates, rather than the cause of plate motion.

**Maintaining tectonic activity.** The interior of the earth has generated enough heat energy to keep the planet tectonically active since it formed at least 4.5 billion years ago. This energy has maintained tectonic activity by keeping the asthenosphere so soft that the lithosphere can sink into it.

The interior of the earth generates heat energy mainly through the radioactive decay of atoms in the crust and mantle. In radioactive decay, radioactive atoms release energetic particles and rays. Material near these atoms absorbs energy from the particles and rays, becoming hotter. See **Radioactivity.**

The production of heat within the earth is declining, mainly because decay is decreasing the number of radioactive atoms. As the earth's heat production is slowing, its interior is cooling. During perhaps the next 5 billion or 10 billion years, this cooling will harden the

asthenosphere so much that plate motion will cease. After that occurs, volcanic eruptions will stop and earthquakes will become infrequent. The earth will be tectonically inactive.

### History of tectonic theory

The theory of plate tectonics developed from a theory of *continental drift,* presented in 1912 by German meteorologist Alfred Wegener. Wegener's theory proposed that the continents move about the surface of the earth. It explained why the shape of the eastern coast of the Americas and that of the western coast of Africa seem to fit together like pieces of a jigsaw puzzle. Evidence for the drift came from the presence of certain rock deposits that indicate the continents have changed position over time. For example, rock deposits from glaciers that existed hundreds of millions of years ago are found in India, Australia, Africa, and South America, indicating that these continents were once in a very cold climate, probably near the South Pole. Fossils of tree ferns and other tropical features in North America indicate that it was once at the equator.

Wegener was not sure what caused continents to drift, however. His theory of continental drift became a subject of much debate among scientists. Then, in the 1920's, British physicist Harold Jeffreys proposed that the deep interior of the earth was very strong and therefore could not flow. As a result, most scientists rejected Wegener's theory.

However, evidence supporting the theory gradually accumulated. In the late 1930's, American geologist David Griggs demonstrated that apparently solid rock can flow slowly when subjected to high temperatures and pressures. In the 1940's and 1950's, other researchers showed that the ocean floor contains much less sediment than would be expected if the floor were a permanent depression. A permanent sea floor would have accumulated more sediment due to the erosion of soil from the continents. And the oldest sea-floor rocks ever found were less than 150 million years old.

In the 1950's, scientists developed techniques for studying rock magnetism that enabled them to determine the positions of the continents millions of years ago. By the late 1950's, scientists completed mapping a system of ocean ridges extending for about 60,000 kilometres and reaching nearly around the world.

In 1960, Harry Hess, an American geologist, proposed a theory of what came to be called sea-floor spreading. Shortly after that, scientists discovered that most earthquakes occur along lines parallel to ocean ridges and trenches. In 1967, American geophysicist Jason Morgan and British geophysicist D. McKenzie independently proposed the idea that the earth's surface consists of a number of movable plates. The following year, American earth scientists Bryan Isacks, Jack Oliver, and Lynn Sykes combined the idea of sea-floor spreading with new results from earthquake detection and proposed that rigid plates of lithosphere move about on a soft, flowing asthenosphere.

In 1969, the drillship *Glomar Challenger* completed its first scientific cruise. Material drilled from various locations on both sides of the Mid-Atlantic Ridge indicated that the age of the ocean crust was exactly as predicted by the analysis of palaeomagnetism and sea-floor

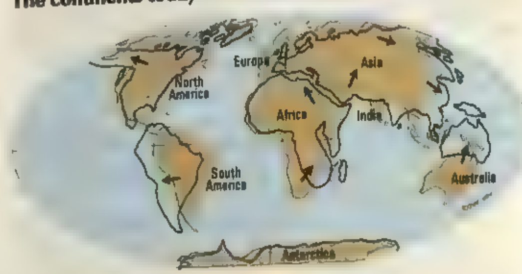
**The drifting continents**

The maps below illustrate the theory of continental drift. The top map shows a single land mass—*Pangaea*—about 200 million years ago. The middle map shows Pangaea broken into the land masses *Laurasia* and *Gondwanaland,* and the present continents forming. The arrows show the direction in which the continents moved. The bottom map shows the continents today and where they may drift during the next 50 million years, *black outlines.*

**Pangaea: The supercontinent 200 million years ago**


**The land masses after 65 million years of drift**


**The continents today and 50 million years from now**




spreading. This discovery and the continuing accumulation of other evidence convinced most earth scientists that the theory of plate tectonics is valid.

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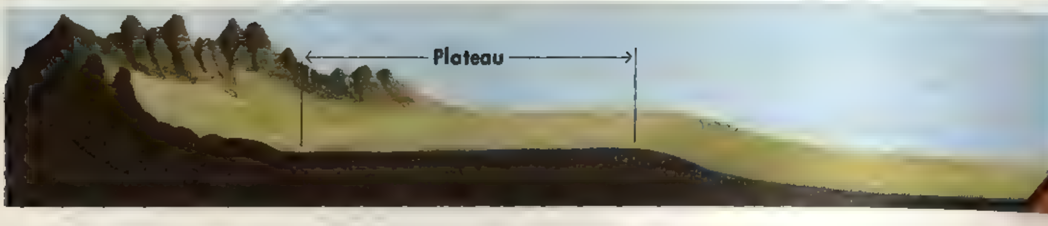
**Plateau** is a raised section of land that covers a considerable area. It is always distinctly higher than the surrounding territory. Plateaus range in height from less than 100 to over 1,000 metres. A *tableland* is similar to a plateau. A *plain* is lower than either a plateau or a tableland. Streams on plateaus often cut valleys which sometimes form canyons, such as the Grand Canyon in the United States. Sometimes a plateau is carved by erosion to look like mountains. The Catskill Mountains in North America are really part of the Allegheny Plateau.




**Plateau** is a large section of raised land. Ranging in height from less than 100 to over 1,000 metres, plateaus can sometimes resemble a mountain range.

Africa is an enormous plateau, most of which is covered with deserts, forests, and grasslands. But the land regions of the continent include plateaus on a smaller scale. The Sahara and Western plateaus together cover most of northern Africa, and the Southern Plateau covers most of the south. In India, the Deccan is a huge plateau which forms most of the southern peninsula. In Australia, the Western Plateau covers the western two-thirds of the country. In North and South America, the higher plateaus, such as the Columbia Plateau, are in the western parts of the continents. The lower ones are in the eastern parts.

The loftiest plateaus on earth are in the Himalaya regions of Central Asia. Here the Plateau of Tibet, often called "the roof of the world", is bordered by high mountain ranges. Some high plateaus are of little value to people because the terrain is too rugged and the climate is unfavourable. Plateaus at lower altitudes are often excellent for grazing. Such pastures are in Australia, India, and the western United States. Plateaus can also provide fertile farmland.

See also **Mesa**; **Pamirs**; **Plain**.

**Platelet.** See **Blood** (Platelets; Blood clotting; pictures).

**Platform tennis** is a variation of tennis which originated in 1928 in the United States. The players—usually two on each side—use paddles to hit a ball back and forth over a net. The game is played outdoors on a raised court enclosed by a tight wire screen 3.7 metres high. The paddles are larger than those used in table tennis, and have small round holes in the surface. The balls are made of yellow sponge rubber.

A platform-tennis court measures 13 metres long and 6 metres wide. The game is played and scored like tennis, with two important differences. A player has only one serve. Also, a player may return a ball that has landed in the court and bounced against the wire fence. Platform tennis originated in 1928 in the United States.

**Plath, Sylvia** (1932-1963), was an American poet and fiction writer. Her works emphasize her sharp insights, ironic wit, and painful feelings. They are especially sympathetic to the plight of women, young people, artists, misfits, and rebels. Plath died young, but she is generally considered one of the most powerful American writers to have emerged since the 1940's.

**Sylvia Plath**

Plath's poems employ vivid, memorable images to depict a world of anguish. "Daddy" dramatizes the hate and love a young woman feels for her father, who died when she was only 10. "Medusa" tells of a daughter's troubled relationship with her mother. In "The Jailer," a wife expresses anger at her brutal, self-centred husband. Poems such as "Ariel" and "Lady Lazarus" explore feelings of despair. "Three Women" presents the thoughts of women as they experience childbirth.

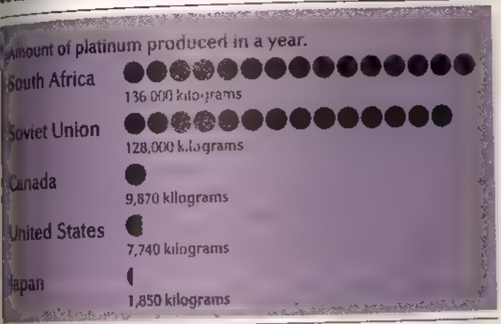
Plath's fiction, like her verse, often explores the dark side of modern life, though usually with humour. In *The Bell Jar* (1963), a college student comes to see her friends as hypocrites and her own values as false. After a suicide attempt, she is able to discover new and more satisfying reasons for living. Plath's short stories, collected in *Johnny Panic and the Bible of Dreams* (1977), focus on the central characters' feelings of loneliness and uncertainty.

Plath was born in Boston. Plath graduated from Smith College in 1955. She married British poet Ted Hughes in 1956. Plath committed suicide at the age of 30. Though little known at the time of her death, she became famous with the publication of *Ariel* (1965), a collection of her poems. *The Collected Poems* (1981) won the Pulitzer Prize for poetry. Plath's writings include a volume of letters to her mother, *Letters Home* (1975); and *The Journals of Sylvia Plath* (1982).

**Platinum** is a chemical element with symbol Pt. It is a precious, silver-white metal that is even more valuable than gold. Its atomic number is 78, and its atomic weight

**Miners drill underground** for platinum ore. The ore is found in small grains that also contain other metals.

**Leading platinum-group metals producing countries**




Figures are for 1989, prior to the breakup of the Soviet Union.
Source: U.S. Bureau of Mines, Statistics Canada. Platinum-group metals include chiefly platinum and palladium, and also iridium, osmium, rhodium, and ruthenium.

is 195.08. Platinum is one of the heaviest substances known. A given quantity of platinum weighs about 21 times as much as an equal quantity of water.

**Properties.** Platinum has many special characteristics that make it valuable. Only gold and silver are easier to shape than platinum. It can be shaped and worked in almost every possible way. It can be drawn into fine wire, or it can be hammered into thin sheets. It does not corrode or tarnish when exposed to air, because it does not combine readily with oxygen or sulphur compounds found in air. Strong acids that dissolve most metals do not attack platinum. Platinum can best be dissolved in a mixture of nitric and hydrochloric acid called *aqua regia* (see **Aqua regia**). It has a relatively high melting point of 1772° C, and is easy to shape. It combines readily with arsenic, phosphorus, and silicon. Platinum also forms alloys with most other metals. The most useful alloys are formed with iridium, nickel, osmium, palladium, rhodium, and ruthenium.

**Uses.** Chemical laboratories often use platinum containers because the metal resists heat and the corrosive effects of many chemicals. For the same reason, platinum parts are sometimes used in large-scale production equipment.

Platinum serves as an effective *catalyst*, a substance that speeds up chemical reactions but is not itself changed in the reaction. The German chemist Johann Wolfgang Döbereiner discovered in the 1820's that platinum functions as a catalyst. He observed that certain organic gases oxidized faster when put in contact with platinum (see **Oxidation**).

Motor vehicle manufacturers use platinum in an emission-control device called a *catalytic converter*. The platinum helps convert certain harmful pollutants into nonpollutants (see **Catalytic converter**). The oil industry also uses platinum to help break down *fractions* (parts) of petroleum to produce petrol of higher octane number (see **Petroleum** [Refining petroleum]). Platinum is also used as a catalyst in making various chemicals, such as acetic acid and nitric acid (see **Catalysis**).

The glass industry uses platinum to make dies for the moulding of fibreglass. Platinum is also widely used in the making of expensive jewellery. The strength, hardness, and colour of the metal, as well as its freedom from tarnish, make it an ideal material for gem settings. Delicate designs can be made in platinum settings. Platinum is also used in the manufacture of the best surgical instruments.

An alloy of platinum with iridium makes an excellent surface for fine engravings. This same platinum-iridium alloy is used in making standards of weights and measures, contact points for electrical equipment, and the tips of fountain pens. Platinum salts are used in some photographic prints. Certain chemical compounds that contain platinum are sometimes used in the treatment of cancer.

**Production.** The Italian scientist Julius Scaliger discovered platinum in 1557. But fairly large quantities were not discovered until about 1750, when the Spaniards found deposits of platinum ore in South America. They named the metal *platinum*, from their word *plata*, meaning *silver*. The ore, called *native*, or crude, platinum, usually occurs in beds of gold-bearing sand. Miners call it *white gold*. Native platinum contains from 60 to 85 per cent pure platinum. Platinum is also obtained from ores in which it is combined with sulphur or arsenic.

The small, irregular grains that contain the ore also bear other rare metals, such as iridium, osmium, palladium, rhodium, and ruthenium. The grains also contain small amounts of iron, copper, chromium, and titanium. Occasionally, a large nugget of native platinum will be found. In 1843, a lump weighing over 9.5 kilograms was found in Russia.

In the late 1980's, South Africa produced the largest share of platinum-group metals. The Soviet Union was the other chief producer. Other producers include Canada, Japan, and the United States.

See also **Element, Chemical** (table); **Iridium**.

**Plato** (427?-347? B.C.) was a philosopher and educator of ancient Greece. He is known as one of the most important thinkers and writers in the history of Western culture.

### Plato's life

Plato was born in Athens. His family was one of the oldest and most distinguished in the city. His mother, Perictione, was a descendant of the great Athenian lawmaker Solon. His father, Ariston, died when Plato was a child. Perictione married her uncle, Pyrilampes, and Plato was raised in his house. Pyrilampes had been a close friend and supporter of Pericles, the statesman who brilliantly led Athens in the mid-400's B.C. The word *Plato* was a nickname, meaning *broad-shouldered*. Plato's real name was Aristocles.

As a young man, Plato wanted to become a politician. In 404 B.C., a group of wealthy men, including two of Plato's relatives—his cousin Critias and his uncle Charmides—established themselves as dictators in Athens. They invited Plato to join them. But Plato refused because he was disgusted by their cruel and unethical practices. In 403 B.C., the Athenians deposed the dictators and established a democracy. Plato reconsidered entering politics. But he was again repelled when his friend, the philosopher Socrates, was brought to trial and sentenced to death in 399 B.C. Deeply disillusioned, Plato left Athens and travelled for several years.

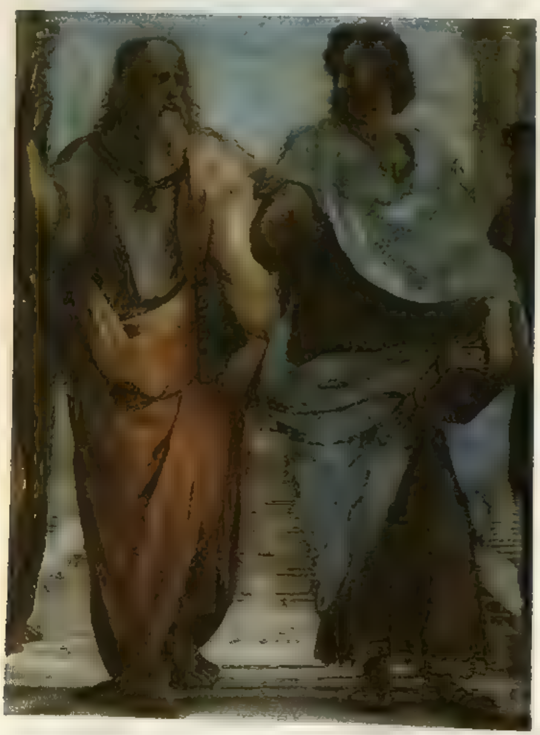
In 387 B.C., Plato returned to Athens and founded a school of philosophy and science that became known as the *Academy*. The school stood in a grove of trees that,

according to legend, was once owned by a Greek hero named Academus. Some scholars consider the Academy to have been the first university. Subjects such as astronomy, biological sciences, mathematics, and political science were investigated there. Except for two trips to the city of Syracuse in Sicily in the 360's B.C., Plato lived in Athens and headed the Academy for the rest of his life. His most distinguished pupil at the Academy was the famous Greek philosopher Aristotle (see **Aristotle**).

## Plato's writings

**The dialogues.** Plato wrote in a literary form called the *dialogue.* A dialogue is a conversation between two or more people. Plato's dialogues are actually dramas that are primarily concerned with the presentation, criticism, and conflict of philosophical ideas. The characters in his dialogues discuss philosophical problems and often argue the opposing sides of an issue. Plato achieved a dramatic quality through the interaction of the personalities and views of his characters. These dramas of ideas have much literary merit. Many scholars consider Plato the greatest prose writer in the Greek language—and one of the greatest in any language.

Plato's better-known dialogues include *The Apology, Cratylus, Crito, Euthyphro, Gorgias, The Laws, Meno, Parmenides, Phaedo, Phaedrus, Protagoras, The Republic, The Sophist, The Symposium, Theaetetus,* and *Timaeus.* A complete edition of Plato's works, collected in ancient times, consists of 36 works—35 dialogues and a group of letters. Scholars today generally agree that about 30 of the dialogues and several of the letters were actually written by Plato. Scholars have also determined to a great extent the order in which the dialogues were written. Thus, Plato's development as a writer and thinker can be traced.



Detail of *School of Athens* (1510-1511); The Vatican, Rome

**The Greek philosophers, Plato,** ***left,*** **and Aristotle,** *right,* as they are pictured by the painter Raphael, in a wall fresco at the Vatican in Rome. The younger man, Aristotle, was greatly influenced by the philosophy of the older.

**The early dialogues** are dominated by Socrates, who appears as a major figure in each. These dialogues include *Charmides, Euthyphro, Ion,* and *Laches.* In these dialogues, Socrates questions people who claim to know or understand something about which Socrates claims to be ignorant. Typically, Socrates shows that the other people do not know what they claim to know. Socrates does not provide answers to the questions. He shows only that the answers proposed by the other characters are inadequate. Most scholars consider these so-called *Socratic dialogues* to be fairly accurate portrayals of the actual philosophic style and views of Socrates. See **Socrates** (The Socratic method).

**The later dialogues.** In the later dialogues, Plato uses the character of Socrates merely as his spokesman. These dialogues include *The Republic, The Sophist,* and *Theaetetus.* In these works, Socrates criticizes the views of others and presents complex philosophical theories. These theories really belonged to Plato, not Socrates. Thus, the later dialogues offer more complete and positive answers to questions being considered than do the early dialogues. But they lack much of the dramatic and literary quality of the earlier writings.

## Plato's philosophy

**The theory of forms.** Many of Plato's dialogues try to identify the nature or essence of some philosophically important notion by defining it. The *Euthyphro* revolves around a discussion and debate of the question, "What is piety?" The central question of *The Republic* is, "What is justice?" The *Theaetetus* tries to define knowledge. The *Charmides* is concerned with moderation, and the *Laches* discusses valour. Plato denied that a notion, such as *piety* (reverence), could be defined simply by offering examples of it. Plato required a definition of a notion to express what is true of, and common to, all instances of that notion.

Plato was interested in how we can apply a single word or concept to many different things. For example, how can the word *table* be used for all the individual objects that are tables? Plato answered that various things can be called by the same name because they have something in common. He called this common factor the thing's *form* or *idea.*

According to Plato, the real nature of any individual thing depends on the form in which it "participates." For example, a certain object is a triangle because it participates in the form of triangularity. A particular table is what it is because it participates in the form of "tableness."

Plato insisted that the forms differ greatly from the ordinary things that we see around us. Ordinary things change, but their forms do not. A particular triangle may be altered in size or shape, but the form of triangularity can never change. In addition, individual things only imperfectly approximate their forms, which remain unattainable models of perfection. Circular objects or beautiful objects are never perfectly circular or perfectly

beautiful. The only perfectly circular thing is the form of circularity itself, and the only perfectly beautiful thing is the form of beauty.

Plato concluded that these unchanging and perfect forms cannot be part of the everyday world, which is changing and imperfect. Forms exist neither in space nor time. They can be known only by the intellect, not by the senses. Because of their stability and perfection, the forms have greater reality than ordinary objects observed by the senses. Thus, true knowledge is the knowledge of forms. These central doctrines of Plato's philosophy are called his *theory of forms* or *theory of ideas.*

**Ethics.** Plato based his ethical theory on the proposition that all people desire happiness. Of course, people sometimes act in ways that do not produce happiness. But they do this only because they do not know which actions will produce happiness. Plato further claimed that happiness is the natural consequence of a healthy state of the soul. Because moral virtue makes up the health of the soul, all people should desire to be virtuous. Plato said that people sometimes do not seek to be virtuous, but only because they do not realize that virtue produces happiness.

Thus, for Plato, the basic problem of ethics is a problem of knowledge. If a person knows that moral virtue leads to happiness, he or she naturally acts virtuously. Plato differed from many Christian philosophers who have tended to view the basic problem of ethics as a problem of the will. These philosophers argue that often people know what is morally right, but face their greatest problem in *willing* to do it.

Plato argued that it is worse to commit an injustice than to suffer one, because immoral behaviour is the symptom of a diseased soul. It is also worse for a person who commits an injustice to go unpunished than to be punished, because punishment helps cure this most serious of all diseases.

**Psychology and politics.** Plato's political philosophy, like his ethics, was based on his theory of the human soul. He argued that the soul is divided into three parts: (1) the rational part, or intellect; (2) the spirited part, or will; and (3) appetite or desire. Plato argued that we know the soul has these parts because they occasionally conflict with each other. For example, a person may desire something but fight this desire with the power of the will. In a properly functioning soul, the intellect—the highest part—should control the appetite—the lowest part—with the aid of the will.

Plato described the ideal state or society in *The Republic.* Plato wrote that, like the soul, this state or society has three parts or classes: (1) the philosopher kings, who govern the society; (2) the guardians, who keep order and defend the society; and (3) the ordinary citizens, farmers, merchants, and craftworkers who provide the society's material needs. The philosopher kings represent the intellect, the guardians represent the will, and the ordinary citizens represent the appetites. Plato's ideal society resembles a well-functioning soul because the philosopher kings control the citizens with the aid of the guardians.

**Immortality of the soul.** Plato believed that though the body dies and eventually disintegrates, the soul continues to live forever. After the death of the body, the soul migrates to what Plato called the *realm of the pure forms.* There, it exists without a body, contemplating the forms. After a time, the soul is reincarnated in another body and returns to the world of the living. But the reincarnated soul retains a dim recollection of the realm of the pure forms and yearns for it. Plato argued that people fall in love because they recognize in the beauty of their beloved the ideal form of beauty that they dimly remember and seek.

In the *Meno,* Plato has Socrates teach an ignorant slave boy a truth of geometry by simply asking a series of questions. Because the boy learns this truth without being given any information, Plato concluded that learning consists of recalling what the soul experienced in the realm of the forms.

**Art.** Plato was critical of art and artists. He urged strict censorship of the arts because of their influence on moulding people's characters. Using his theory of forms, Plato compared artists unfavourably with craftworkers. He declared that a table made by a carpenter is an imperfect copy of the ideal form of a table. A painting of a table is thus a copy of a copy—and twice removed from the reality of the ideal form.

Plato claimed that artists and poets cannot usually explain their works. Since artists do not even seem to know what their own works mean, Plato concluded that they do not create because they possess some special knowledge. Rather, he believed that artists create because they are seized by irrational inspiration, a sort of "divine madness."

## Plato's place in Western thought

After Plato died, his nephew Speusippus took over the leadership of the Academy. The school operated until A.D. 529. That year, the Byzantine Emperor Justinian I closed all the schools of philosophy in Athens because he felt they taught paganism.

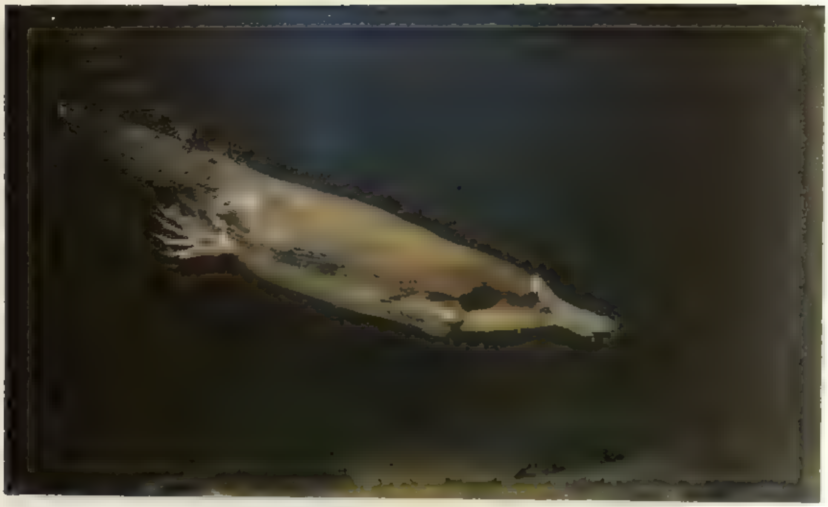
However, Plato's influence was not confined to the Academy. Plato's philosophy deeply influenced Philo, an important Jewish philosopher who lived in Alexandria shortly after the birth of Christ. During the A.D. 200's in Rome, Plotinus developed a philosophy that was based on Plato's thought. This new version of Plato's philosophy, known as *Neoplatonism,* had great influence on Christianity during the Middle Ages. See **Plotinus; Neoplatonism.**

Plato dominated Christian philosophy during the early Middle Ages through the writings of such philosophers as Boethius and Saint Augustine. During the 1200's, Aristotle replaced Plato as the greatest philosophical influence on the Christian world. A revival of interest in Plato developed during the Renaissance. During the 1400's, the Medici family, famous patrons of the arts, established a Platonic Academy in Florence, Italy, as a centre for the study of Plato's philosophy. In the mid-1600's, an important group of English philosophers at Cambridge University became known as the Cambridge Platonists. They used the teachings of Plato and the Neoplatonists to try to harmonize reason with religion.

See also **Philosophy** (Ancient philosophy); **Atlantis.**

**Platt Amendment.** See **Cuba** (United States control; The Batista era).

**Platyhelminth.** See **Flatworm.**



**The platypus** has a broad, flat tail and webbed feet that aid in swimming. It lives along streams in Australia and is often called the *duckbill* because its snout resembles the bill of a duck. The platypus and the echidna are the only mammals that lay eggs.

**Platypus** is one of only two mammals that reproduce by laying eggs. The echidna, or *spiny anteater,* is the other. Platypuses are often called *duckbills* because they have a broad, flat, hairless snout that resembles the bill of a duck.

Platypuses live along streams in Australia. They have webbed feet and a broad, flat tail that aid in swimming. The platypus uses its bill to scoop up worms, small shellfish, and other animals from the bottom of streams. Adult platypuses lack teeth. They crush their food with horny pads at the back of the jaws. Platypuses grow from about 40 to 56 centimetres long, including a tail of 10 to 13 centimetres. They weigh about 2.5 kilograms but appear heavier because of their thick coat of brown fur.

The platypus has claws on its front and hind feet, but the webs of the front feet can be extended beyond the claws. The platypus folds these webs against the palms when walking on land or digging in the ground. Male platypuses also have a hollow clawlike *spur* behind each ankle. The spurs are connected to poison glands, which enlarge during the mating season. Scientists believe the male platypuses might use the spurs to defend themselves.

Platypuses live in burrows that they dig in the banks of streams. The burrows may be as long as 26 metres. Except for female platypuses with their young, each animal lives in its own burrow. During the mating season, the female builds a nest of leaves and grass at the end of her burrow. Before laying her eggs, she blocks the entrances to the burrow with dirt. Female platypuses lay from one to three eggs at a time. The eggs measure about 1.5 centimetres in diameter and have a leathery shell. They hatch after about 10 days. Young platypuses remain in the burrow for about four months and feed on their mother's milk.

At one time, platypuses were hunted for their fur. Since the 1920's, however, the killing of platypuses has been prohibited by law.

**Scientific classification.** The platypus makes up the family Ornithorhynchidae in the mammalian order Monotremata. Its scientific name is *Ornithorhynchus anatinus.*

See also **Mammal** (picture: Monotremes).

**Plautus** (254?-184 B.C.) was an important Roman writer of comedy. His plays are versions of Greek New Comedy, which emphasized young men in love with slave girls, mistaken identities, cunning servants, and deceived masters. Plautus added earthy Italian comic elements and his own boisterous wit. Subtle techniques of plot construction and characterization did not concern him as much as producing laughter. He was a master of dialogue, writing a lively stream of puns, love talk, and abuse.

Plautus wrote many plays, of which 21 have survived. *Amphitruo* is a mythological story about the god Jupiter fathering Hercules with a human man's wife. In *Menaechmi,* two long-separated brothers find each other after great confusion. William Shakespeare used the theme of this play as the basis for his *Comedy of Errors.* In *Casina,* another of Plautus' plays, father and son are rivals for the same girl.

Titus Maccius Plautus was born in Sarsina, Italy. He apparently worked as a stagehand with a travelling acting troupe before turning to playwriting.

**Play.** See **Drama; Theatre.**

**Play,** in recreation, is any activity performed for amusement. Although people engage in play mainly to enjoy themselves, play also contributes to the physical and mental health of individuals. For example, many people increase their physical fitness by swimming or hiking. Many people also improve their intellectual skill by playing word games or solving puzzles.

Play activities fall into one of three general groups—(1) motor play, (2) intellectual play, or (3) sensory play. Motor play is physical exercise, such as skating or playing volleyball. Intellectual play primarily involves mental activity. Chess is a popular game of intellect. Sensory play includes spectator activities, such as attending sports events.

Play takes countless forms. A person may bounce a ball alone or join in a game of basketball with several other people. Play activity may or may not be planned. It can take place anywhere, from in an individual's mind to areas designed specifically for play, such as sandpits, playgrounds, recreation rooms, and athletic fields.

Some play activities are popular with both children

and adults. Other activities appeal primarily to people of certain age groups. Children often take part in play that requires a great deal of imagination, such as playing with dolls or dressing up and pretending to be adults. Play activities for adults generally involve more structured recreation, such as hobbies, sports, and games.

For a child, playing is a form of self-expression and a significant part of social development. Children begin to play long before they can communicate effectively with words. Through playing, they express their ideas, moods, problems, and personalities to other people. Children learn to interact with one another by sharing toys or playing games that stress personal cooperation, such as tag or hide-and-seek. When they are older, they develop teamwork skills by playing competitive sports like volleyball.

For an adult, playing is a way of relaxing during leisure time. Play activities help relieve pressures caused by the tensions of daily life.

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**Intellectual play** involves mental activity. Chess players, *above*, must use their powers of concentration in order to evaluate a large number of possible moves and strategies.

**Motor play** is physical exercise such as playing volleyball, *above*. Playing competitive sports helps develop teamwork skills, and may contribute to the physical and mental health of individuals.

**Player, Gary** (1935- ), a South African sportsman, became one of the world's leading golfers in the 1960's and early 1970's.

Gary Player

Gary (Jim) Player was born in Johannesburg. He became a professional golfer at the age of 20. His first notable achievement came in 1958, when he was runner-up in the U.S. Open Championship. One year later, he became the youngest winner of the British Open. In 1960, he won the U.S. Open, and the following year triumphed in the U.S. Masters Championship. At that time he was the only non-American golfer to have won the *Grand Slam* (the four major titles in one season).

After winning the South African Open in 1956, Player was named South African Sportsman of the Year, and was later nominated for the same title many times.

Player is celebrated for his fitness, concentration, and superb putting ability. His conduct both on and off the golf course makes him a popular and respected unofficial ambassador for his country.

**Playford, Sir Thomas** (1896-1981), was premier of South Australia from 1938 to 1965. He was premier continuously for 27 years, holding the office longer than any other premier in Australia. During his premiership, he also served as treasurer and minister for immigration. His government introduced policies that made South Australia a centre of thriving industries. Before he took office, the state had been largely agricultural.

**Children at a playground** climb and slide on the equipment. The grass field behind the equipment is used for games and sports for older children and adults. City planners in many countries provide for playgrounds in communities, and most schools have them.

Playford was born at Norton's Summit, in South Australia. His grandfather, Thomas Playford, had been premier of South Australia. He left school at the age of 12. During World War I, he served in Gallipoli, Turkey, and in France. In 1933, he was elected to the House of Assembly as Liberal and Country League candidate for the district of Murray. From 1938, he represented Gumeracha in parliament. In the same year, he became commissioner of Crown lands. After his party lost the state elections of 1965, he became leader of the opposition. He retired from parliament in 1968.

Playford was knighted in 1957.

**Playground** is an outdoor area set aside for play. Most playgrounds are designed for children, but in some countries, such as the United States, playgrounds also have sports facilities for adults. In countries such as the United Kingdom, playing areas with sports facilities are usually called playing fields. The term *playground* usually means a children's playing area with swings, roundabouts, climbing frames, and other sorts of play equipment. This article deals only with playgrounds of this latter type.

Schoolyards often contain the kind of apparatus found in playgrounds. This apparatus includes climbing frames, sandpits, slides, and swings. Such equipment helps children in their play during morning and afternoon breaks in their lessons. Schoolyards are often referred to as school playgrounds. For an account of the value of play in a child's development, see **Play**.

Practically all schools have school playgrounds. In addition to these school playgrounds, many local communities maintain public playgrounds where children can play outside school hours. City playgrounds usually come under the control of local authority parks and recreation departments. Playgrounds form a very important aspect of town and city planning. Local building regulations often require that new housing estates or residential complexes include space for public parks and playgrounds for children.

In some countries, adult teachers or playground leaders supervise play activities at playgrounds. Such people generally have a qualification in physical education and also a training in first aid. Playground leaders may organize special activity programmes to give structure to children's play. Good playground leaders know all sorts of games, dances, and other activities and how to interest other people in them.

**Adventure playgrounds** are a chiefly British phenomenon. They are playing areas that contain various types of building materials (such as bricks) or discarded items of industrial equipment (such as pipes, tractor tyres, or old machinery). Children can build things, climb onto or hide inside things, and generally make up games that act out exciting adventures.

**History.** Before the 1900's, children in most countries could only play on the land surrounding their homes, on areas of open ground, or in the streets. A movement to start providing public playgrounds was started shortly before 1900 by an American journalist from New York named Jacob Riis. Riis and others recognized the need for play space in the growing cities of the United States and elsewhere. Slum areas had few open spaces, and few publicly run schools of the period had any land around them for school playgrounds. The city of Boston led the way in setting aside space for play. By 1899, Boston had 21 sandpits for children. Other cities followed Boston's example, and playgrounds were soon provided in major cities in many parts of the world.

See also **Gymnasium**; **Park**; **Play**; **Recreation**.

**Playing cards.** See **Card game**.

**Plea bargaining** is a practice in which the defendant in a criminal case agrees to plead guilty instead of going to trial. In some cases, the prosecuting authority promises to drop one or more charges or to substitute a less serious charge in exchange for a guilty plea. Alternatively, the prosecutor may promise to recommend that the accused receive a lighter sentence than ordinarily would be given provided he or she pleads guilty. In the

United States, about 90 per cent of all defendants plead guilty, most as a result of plea bargaining.

Many lawyers and other experts on criminal justice favour plea bargaining because it saves the time and money involved in deciding each case by trial. Other supporters believe that a lawbreaker who openly acknowledges guilt has shown regret and deserves a lighter sentence.

Many critics of plea bargaining believe it allows large numbers of criminals to be punished less severely than they deserve. Other opponents fear that the procedure jeopardizes a defendant's right to be considered innocent until proved guilty. They argue that plea bargaining may force even innocent people to agree to a criminal charge because of a fear of going to trial.

**Plebeians** were commoners in the early Roman Republic. The plebeians included freed slaves, peasant farmers, and dependents of *patricians* (aristocrats). It is not known how the difference between plebeians and patricians first arose, but it existed by the early 500's B.C.

Plebeians who owned property served in the army and, like the rest of their class, were denied many rights. For many years, they could not hold public office, vote on laws, or become priests. They were forbidden to marry persons not of their class. Judges often treated the plebeians unfairly.

Early in the 400's B.C., the plebeians threatened to refuse to fight unless they were allowed to choose their own *tribunes* (officials). The plebeians were given the right to elect tribunes who could *veto* (reject) unfair acts of judges and lawmakers. Later, in 445 B.C., the plebeians received the right to marry patricians. In 367 B.C. they were allowed to run for the office of *consul* (chief government official). By 300 B.C. they had been declared eligible for the priesthoods and other offices. In 287 B.C., the *comitia tributa* (assembly of all the people—plebeians and patricians alike) was given the power to make laws that bound everyone.

Wealthy plebeians then began joining the patricians to form a new upper class. But tribunes and the *comitia* remained to protect the poor classes of Rome until the end of the republic, in 27 B.C.

See also **Patricians; Praetor; Tribune.**

**Plebiscite** is a vote of the people on any question. But the term has come to mean the vote of inhabitants in a territory to choose the nation that will govern them. The plebiscite was first used during the 1790's when the citizens of Nice and Savoy chose to vote for or against union with France.

Modern plebiscites are almost always under international supervision. In 1975, for example, the United Nations (UN) sent observers to witness a plebiscite in the Mariana Islands in the Pacific Ocean. All the islands except Guam were governed by the United States as part of a UN trust territory. In the plebiscite, the people voted to become a commonwealth of the United States. Plebiscites also decided the status of the Saar in Europe and British Togoland in Africa.

Plebiscites are intended to give territories freedom of choice, but interested nations sometimes try to influence the vote by military pressure. In any case, plebiscites have marked a long step forward in permitting people of certain territories some freedom in choosing their form of government.

**Plecoptera** is an order of insects that lay their eggs in water. The young live in streams or along the rocky shallows of ponds and lakes. They form a large part of the diet of trout and other fish. The adults have wings but do not fly well and seldom wander far from their breeding place. They often can be seen clinging to rocks at the water's edge. Thus, they are commonly called *stone flies.*

See also **Stone fly.**

**Pledge.** See **Oath.**

**Pledge of Allegiance** is a solemn promise of loyalty to the United States. It reads:

> I pledge allegiance to the flag of the United States of America and to the Republic for which it stands, one Nation under God, indivisible, with liberty and justice for all.

School children first recited the pledge as they saluted the flag during the National School Celebration held in 1892 to mark the 400th anniversary of the discovery of America. The original pledge was written by either James Upham (1845-1905) or Francis Bellamy (1855-1931), both of Boston, Massachusetts, or possibly jointly by these men, who worked for *The Youth's Companion.* The National Flag Conferences of the American Legion expanded the original wording in 1923 and 1924. In 1942, the U.S. Congress made the pledge part of its code for the use of the flag. In 1954, it added the words "under God."

**Pleistocene Epoch** was a geologic time period in the earth's history. Many earth scientists believe this epoch began about 2 million years ago and ended about 10,000 years ago.

The Pleistocene Epoch included a period called the Ice Age, when a series of ice sheets covered large regions of land. Anthropologists believe an early form of human being gradually developed into the modern form during the Pleistocene Epoch.

See also **Ice Age; Earth** (Outline of the earth's history); **Prehistoric people.**

**Plekhanov, Georgi Valentinovich** (1856-1918), was a leading advocate and interpreter of Marxist ideas in Russia during the late 1800's and early 1900's. Plekhanov, the youngest son of a minor noble, was born in Gudalovka, near Tambov, Russia. As a young man, he joined a revolutionary movement that wanted to establish socialism in Russia. In 1880, he fled to Switzerland to escape arrest for his political activities. There, he became a follower of Karl Marx, the German founder of Communism.

Plekhanov adapted Marx's ideas to Russian conditions and projected a two-stage revolution to achieve a socialist state. In the first stage, the working and middle classes would defeat the Russian monarchy. In the second stage, the workers would overthrow the middle class and come to power.


Georgi Plekhanov

In 1883, Plekhanov helped found the first Russian Marxist organization,

the Emancipation of Labour group. This group led to the formation of the Russian Social Democratic Labour Party in 1898. At its second convention in 1903, the party adopted a platform based on Plekhanov's theory of a two-stage revolution.

Plekhanov disagreed with V. I. Lenin, another Russian socialist, on many political questions. Their differences came to a head during World War I (1914-1918). Plekhanov wanted Russia to remain in the war and help France and the United Kingdom to win. Lenin proposed to turn the war into a worldwide revolution. In 1917, Lenin and his followers seized power and established a Communist government in Russia.

**Plesiosaur** was a prehistoric marine animal that lived about 200 million years ago. It looked like a huge whale with paddlelike limbs. See **Prehistoric animal** (The Age of Reptiles).

**Pleura** is a thin membrane that lines the *thoracic cavity* (chest cavity) and covers the lungs. The part covering the lungs is called the *visceral pleura,* or *pulmonary pleura.* The remaining part, the *parietal pleura,* lines the chest wall and covers the diaphragm. The two parts unite at the root of the lung, where the *bronchus* (branch of the windpipe) and blood vessels enter the lung.

In a healthy person, the two parts of the pleura touch. They secrete a trace of watery fluid that lubricates their surfaces. Inflammation of the pleura, a condition called *pleurisy,* can cause fluid to accumulate between the two pleural surfaces, possibly compressing the lung underneath. If a hole develops in the surface of the lung, air enters the space between the pleural surfaces. This condition, called *pneumothorax,* may cause the lung to collapse.

See also **Lung; Membrane; Pleurisy; Pneumothorax.**

**Pleurisy** is a general term for inflammation of the *pleura,* the membrane that lines the inside of the chest and covers the lungs (see **Pleura**). The two surfaces of the pleura are normally moist and allow the lungs to move smoothly over the chest wall when a person breathes. When the pleural surfaces are inflamed, they become dry and rough and rub together. The inflammation stimulates pain receptors in the pleural lining of the inside of the chest and causes intense pain, made worse by coughing and deep breathing.

Pleuritic pain is often accompanied by *pleural effusion,* an accumulation of excessive amounts of fluid in the space between the two parts of the pleural membrane. In some cases, so much fluid collects in this cavity that the lungs become compressed and cannot inflate normally. Chills and fever, coughing, and difficulty in breathing may also accompany pleurisy.

Most cases of pleurisy occur as complications of pneumonia, tuberculosis, or other infectious diseases. Doctors must therefore treat the underlying disease in order to cure pleurisy. A doctor may prescribe drugs to relieve pain. In cases of pleural effusion, a doctor may drain fluid from the patient's chest.

**Plexus,** in anatomy, is a network of intertwining parts. In a nerve plexus, such as the *brachial plexus* that supplies the arm, there is a complex interweaving of nerve fibres. In a *vascular plexus,* made up of arteries, veins, or lymphatic vessels, the vessels are connected with each other.

See also **Solar plexus.**

**Plimsoll, Samuel** (1824-1898) was a British coal merchant and member of Parliament who won fame because of his interest in the welfare of sailors. During the 1800's and earlier, the dangerous overloading of cargo ships for extra profit was commonplace. As the member of Parliament for Derby, Plimsoll helped introduce a Merchant Shipping Bill to prevent this abuse (see **Plimsoll mark**). In 1875, Plimsoll led a violent protest against shipping owners who opposed his bill. In 1876 the bill became law as the Merchant Shipping Act. Plimsoll became known as "the Sailor's Friend."

Samuel Plimsoll was born in Bristol. He moved to London and helped organize the Great Exhibition of 1851 and began work as a coal merchant in 1853. He entered Parliament in 1868.

**Plimsoll mark,** or Plimsoll line, is a load-line marking on the side of a ship's hull. It shows the *draught* a ship can be safely loaded to under certain conditions. The draught is the depth to which a ship sinks in the water. The position of the marking depends on the type and size of the vessel. A ship loaded "down to the Plimsoll mark" carries the maximum weight of cargo. Any more cargo would submerge the Plimsoll mark and lessen the ship's chances of a safe voyage.

**A Plimsoll mark,** like the one being measured above, indicates how much cargo a ship can carry safely. A ship has the maximum cargo when the water level reaches the horizontal line.

The name comes from Samuel Plimsoll, a British member of Parliament who was active in promoting the Merchant Shipping Act of 1876. This act was the first legislation to require a draught mark on the side of a vessel beyond which it could not be loaded.

An International Load Line was adopted in 1930, and in 1966 the world's seagoing nations signed a Load Line Convention.

See also **Ship** (Safety at sea).

**Pliny** is the family name of an uncle and a nephew who were Roman writers.

**Pliny the Elder** (A.D. 23-79), or Gaius Plinius Secundus, wrote many historical and technical works. Only his 37-volume *Natural History* has survived. Although this

work was used during the Middle Ages, its only value now is to show the state of scientific knowledge during Pliny's time. See **Geology** (The Romans).

Pliny was born in Novum Comum (now Como) in northern Italy. As a lawyer, he held important public offices. He was admiral of the fleet near Pompeii when Mount Vesuvius erupted in A.D. 79, and he died there trying to help the refugees.

**Pliny the Younger** (A.D. 61?-113?), or Gaius Plinius Caecilius Secundus, was the nephew of Pliny the Elder. His most important works are his *Letters,* collected in 10 books. They show the life and interests of a Roman gentleman, scholar, and philanthropist. Some of the letters, addressed to the historian Tacitus, give a detailed account of the eruption of Vesuvius, and describe his uncle, Pliny the Elder.

Pliny served as governor of Bithynia, and wrote letters to the Emperor Trajan describing the Christians and asking what to do about them. These letters are the earliest accounts of Christians written by a pagan. Pliny was born in Novum Comum. He was well educated, and by the time he was 20 was considered one of the most learned persons of his time. Pliny studied under Quintilian and was a good orator.

**Pliocene Epoch.** See **Earth** (table: Outline of the earth's history).

**Plique-à-jour** is a delicate type of enamelling. The enamel is put in openings in the object to be enamelled, so that it looks like a miniature stained-glass window. The art of plique-à-jour lies in keeping the enamel together until it has been permanently fused by heat. Plique-à-jour enamels are the most translucent enamels, because they have no background to stop the light. Glittering plique-à-jour enamels often give the effect of small jewels.

See also **Enamel** (Decorative enamelling techniques).

**PLO.** See **Palestine Liberation Organization.**

**Ploiești** (pop. 199,269; met. area pop. 254,592) is the centre of the Romanian oil industry. The city lies in a large oil-producing region of south-central Romania. For location, see **Romania** (map).

Ploiești has plants that manufacture oil-mining equipment, refine oil, and produce chemicals from petroleum. Pipelines and railways link the city with Constanța on the Black Sea. Ploiești is also a textile-manufacturing centre.

**Plot.** See **Drama** (The structure of drama); **Literature** (Plot).

**Plotinus** (205?-270?), was the founder of a school of Greek philosophy known as *Neoplatonism.* He developed Neoplatonism from the philosophy of Plato (see **Neoplatonism**). Plotinus said that the material world is unreal, politics trivial, the body a temporary prison for the soul, and life a journey through a landscape of illusion. Reality lay "yonder" in a solitary perfect being, *The One,* the source of all truth, goodness, and beauty. He said that pure souls may hope to "return" there. Sometimes this return occurred as a mystical vision. Plotinus believed he had experienced such a vision.

Plotinus may have been born in Egypt. He joined a military campaign to the East to try to learn more about Indian philosophy. Plotinus spent the last years of his life teaching in Rome. He disliked writing but dictated 54 lectures in six 9-lecture sets called the *Enneads.* Plotinus' pessimism reflects only one side of Plato's philosophy—that in which philosophy is seen as a consolation or as an escape from the world. But this was the side most appealing to Romans of Plotinus' time.

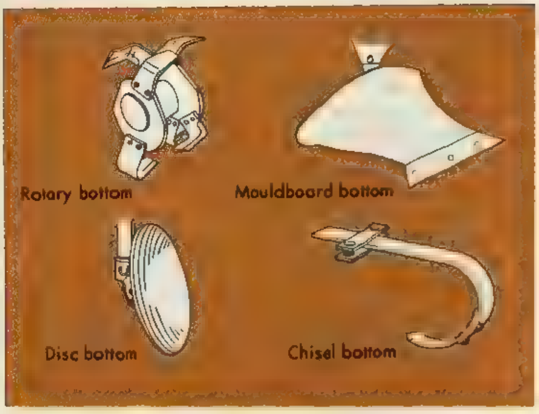
**Plough** is a tool used to prepare soil for planting. A plough digs into the ground and pushes, cuts, and lifts the soil to break it up. Much of the world's food comes from crops grown in ploughed fields and from foodproducing animals that feed on such crops.

Farmers *till* (plough) the soil for many reasons. Ploughing reduces the hardness of the upper 15 to 40 centimetres of the earth's crust, making seed planting easier. Tillage also aids planting by covering up the *residue* (remains) of the previous crop and by killing weeds and insects. Air movement into the earth increases, and oxygen can act more quickly on organic matter in the soil to speed the release of plant nutrients. Plants growing in the soil can also take in more oxygen through their roots and thus grow more rapidly.

### Kinds of ploughs

There are four chief kinds of ploughs: (1) the *tractor plough,* (2) the *walking plough,* (3) the *sulky plough,* and (4) the *gang plough.* In developed countries, almost all farmers use a tractor plough. Most farmers in developing countries use a walking plough. Sulky ploughs and gang ploughs have almost disappeared from use. Practically all ploughs used today are made of iron and steel, but some are built of wood.

**A tractor plough** is pulled by a tractor. The plough shown above has seven furrowing spades, called *bottoms.* It uses *mouldboard* bottoms, the most popular type of plough bottom.




**Plough bottoms** are manufactured in four main designs. The *rotary bottom* mixes crop residue with the soil. The *mouldboard bottom* buries residue. The *disc bottom* tills hard, sticky, or stony land. The *chisel bottom* leaves residue on the surface.

**The tractor plough** is pulled by a tractor. This type of plough has from 1 to 10 or more *bottoms* (furrowing spades) mounted on its frame. *Colters* (disc blades) can also be mounted on the frame to cut residue.

**The walking plough** is pulled by horses, mules, or oxen. The farmer must walk behind and hold the handles to guide the plough.

**The sulky plough** has a seat and wheels, and so the farmer can ride while tilling. Horses pull the sulky plough, which was invented in 1875 by John Deere, an American blacksmith.

**The gang plough,** a horse- or tractor-drawn plough, also allows the farmer to ride while tilling. It has two or more bottoms and three wheels. A gang plough can till as many furrows at a time as it has bottoms. A walking plough and a sulky can till only one at a time.

### Kinds of plough bottoms

Farmers also classify ploughs according to the types of bottoms they have. There are four main kinds of plough bottoms: (1) the *mouldboard,* (2) the *disc,* (3) the *chisel,* and (4) the *rotary.*

**The mouldboard plough bottom** ranks as the most widely used type. A mouldboard plough *moulds* (covers and buries residue) as it tills. The mouldboard bottom has three main parts: (1) the *share,* (2) the *landside,* and (3) the *mouldboard.* They are bolted onto a frame called the *frog,* which holds them together in the shape of a three-sided wedge.

***The share*** is the sharp edge that cuts the furrow slice loose from the ground. It uses most of the power required to pull the plough bottom through the soil.

***The landside*** fits behind the point of the share and below the mouldboard. It slides along the land at the bottom of the furrow, where a slice of soil has been cut out, and stabilizes the plough.

***The mouldboard*** is above and to the rear of the share. It turns the soil, breaks it up, and moves it to one side. Farmers use four types of mouldboards. A *stubble* mouldboard is short and sharply curved. It may be used for slow ploughing in soils that *scour* (slide cleanly off the mouldboard). A *general-purpose* mouldboard has a longer curve, which makes it useful for average scouring conditions and ploughing speeds. A *high-speed* mouldboard has an even longer curve and can plough

**Egyptian farmers** tilled their fields with wooden walking ploughs in 1300 B.C. They used oxen to pull the ploughs.

Detail of *American Farm Scenes #1: Spring* (1853), a hand-coloured lithograph by Frances Palmer, printed by Nathaniel Currier

**Farmers** in 1853, like the ancient Egyptians, used a plough pulled by oxen. But this plough had a steel bottom.

**The sulky plough** allowed farmers to ride while they ploughed.

**Steam-powered ploughs** came into use in the early 1900's. Such machines were costly and hard to repair.

at higher speeds without throwing the soil too far to the side. A *slatted* mouldboard consists of long curved steel slats, which provide little surface area for sticky soils to cling to.

**Other types of bottoms** provide greater efficiency than mouldboards in certain situations. The bottom of a *disc plough* consists of a disc-shaped blade designed to till hard, sticky, or stony land. The *chisel plough* has narrow, C-shaped bottoms. Chisel ploughs lift the soil without turning it over. This action leaves crop residue on the surface where it can reduce the *erosion* (wearing away) of soil that results from the movement of wind and water. A *rotary plough* has many bent rotating blades that mix residue with the soil.

### History

The people of most prehistoric civilizations never tilled the soil. They merely punched holes in the ground with a stick to bury the seed and hide it from birds and rodents. Then, more than a million years ago, people discovered that plants grew better in soil that had been loosened. They began to use such objects as sharp sticks, rocks, bones, or shells to pry loose chunks of dirt before planting the seed.

The first plough was made about 8,000 years ago. A farmer sharpened one prong of a forked branch to turn the soil and probably hitched a person to the other prong. The farmer guided the implement by holding the branch's stump while the other person pulled. Later, oxen were used to pull the plough, and a pointed iron spade replaced the bottom prong.

See also **Agriculture; Deere, John; Wood, Jethro.**

**Plovdiv** (pop. 350,438) is Bulgaria's second largest city. Only Sofia has more people. Plovdiv is an agricultural, industrial, and railway centre. It lies on the Maritsa River (see **Bulgaria** [map]).

Plovdiv is Bulgaria's chief marketing centre for tobacco and perfume. It has leather, metal, and textile industries, and it processes farm products. Plovdiv holds a major international trade fair twice a year.

By the 400's B.C., a Thracian town existed at what is now Plovdiv. Philip of Macedonia captured it in 341 B.C. From about the time of the birth of Christ until about A.D. 300, the town flourished as part of the Roman Empire. It later changed hands many times before the Turks captured it in 1364. In 1878, Plovdiv became capital of Eastern Rumelia, a partly self-governing province in the Ottoman Empire. It united with the rest of Bulgaria in 1885.

**Plover** is the name for a group of small, stout shore birds. The plover has a short body and a short bill. It secures its food from the surface of the ground rather than by probing. Most plovers have only three toes. The plover has a short, thick neck. Its wings are pointed and reach beyond the end of its tail.

The plover builds its nest on the ground. The female usually lays four eggs. The eggs are so spotted that they are hard to distinguish from the pebbles around them. When the bird hatches, it is usually covered with light-brown or grey feathers marked with dark spots.

There are many kinds of plover throughout the world. The smallest plovers are the true plovers. They live on the seashore, alongside rivers, or in fields. The *ringed plover* is widespread along coastlines in Europe, and breeds as far north as the Arctic tundra. It winters around the eastern Mediterranean or on the North African coast.

Medium-sized plovers are the lapwings, which are found in all tropical and temperate areas except North America. The *Eurasian lapwing,* or *peewit,* inhabits marshlands, lakeshores, grasslands, and even *arid* (dry) terrain. It is noted for flying off ahead of an incoming cold front and returning when the weather turns milder.

The largest plovers include the *Eurasian golden plover* and the *American golden plover.* They breed in freshwater marshes and grasslands in upland and tundra regions of the Northern Hemisphere.

One of the rarest plovers is the *New Zealand shore plover.* It is an endangered species.

**Scientific classification.** Plovers belong to the plover and lapwing family Charadriidae. The ringed plover is *Charadrius hiaticula;* the Eurasian lapwing is *Vanellus vanellus;* the Eurasian golden plover is *Pluvialis apricaria;* the American golden plover is *P. dominica;* the New Zealand shore plover is *C. novaeseelandiae.*

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**Plowman, Piers.** See **Langland, William.**

**Plowright, Joan** (1929- ), became a leading British actress in the late 1950's with fine performances in such plays as *The Entertainer.* She began her professional career in 1948, at the Croydon Repertory Theatre. Later, she performed at the Nottingham Playhouse, and at the Royal Court Theatre, in London. She joined the National Theatre company in 1963. She was born at Brigg, in Humberside, England. In 1961, she married Sir Laurence Olivier, later Lord Olivier (see **Olivier, Laurence**).

**Plum** is a popular fruit that is eaten fresh or used to make jams, jellies, and preserves. Some varieties of plums are dried to make prunes (see **Prune**).

Plums grow on trees that range in height from about 2 to 5 metres. A plum may be as small as a cherry or as large as a small peach. Plums have a smooth, thin skin surrounding a thick, juicy flesh. A hard pit in the centre of the fruit contains one or two seeds. Plums may be heart-shaped, oval, or round. Commercial varieties measure from 25 to 64 millimetres in diameter. They may be black, blue, green, purple, red, or yellow, depending on the variety.

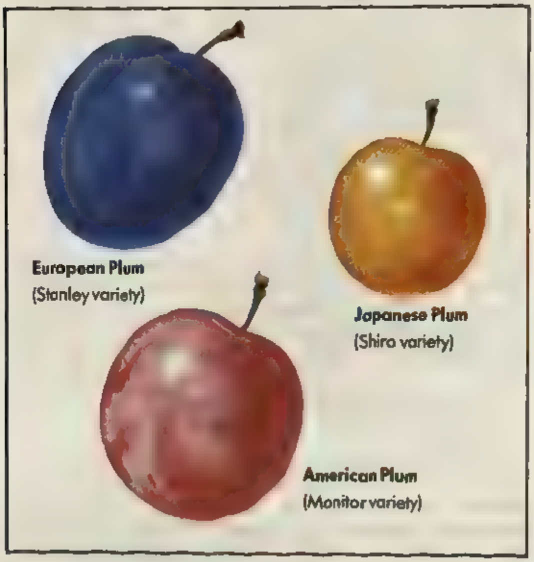
About 6 million metric tons of plums are produced in the world annually. The leading plum-producing countries include China, Germany, Italy, Romania, and the United States.

**Kinds of plums.** There are three main kinds of plums: (1) European, (2) Japanese, and (3) American.

*European plums,* often called *domesticas,* are the most widely grown type of plum. They are blue or red in colour, and range in size from medium to large. They originated in southwestern Asia and have been grown in Europe for more than 2,000 years. Important varieties include Bradshaw, Grand Duke, Lombard, Reine Claude, and Stanley. Certain extremely sweet varieties of European plums, including French, Italian, and Sugar, can be dried to make prunes. Prunes keep for much longer than fresh plums.

### Kinds of plums

The three main kinds of plums are European, Japanese, and American. European plums are the most widely grown. Japanese plums are firm and juicy. American plums are hardy and can grow in colder climates than European and Japanese plums.




*Japanese plums,* or *Salicina plums,* may be eaten fresh or cooked. These yellow, crimson or purple fruit can be made into fine jam, but not into prunes. Japanese plums are generally firm and juicy. Varieties include Abundance, and Shiro. Japanese plum trees originally grew wild in China.

*American plums* grow on trees that were developed from wild plum trees of North America. The trees are not widely cultivated, but they can survive in much colder climates than European and Japanese plum trees can. Varieties of American plums include Cheney, De Soto, Golden Beauty, and Monitor.

**Growing plums.** Growers produce plum trees by attaching plum tree buds onto a *rootstock,* a part of another plant that provides the buds with a root system (see Grafting). Growers plant the trees about 6 metres apart and carefully prune them during the first few years of growth to produce strong, well-shaped trees.

Plum trees generally flower from one to five years after planting. They produce beautiful white blossoms in the early spring and, if pollinated, develop into mature fruit by late summer. Most varieties of plum trees are *selfunfruitful*—that is, they cannot produce fruit with their own pollen and must be pollinated by other varieties. Honey bees play an important role in carrying pollen from tree to tree.

**Diseases and pests.** Major diseases that infect plum trees include the fungal diseases *black knot* and *brown rot.* Growers control these diseases by spraying with fungicides or by removing and destroying infected parts of the trees. *Plum curculio* is a serious insect pest that lays its eggs in holes it eats in the fruit. It is controlled through the use of insecticide sprays.

**Scientific classification.** Plums belong to the rose family, Rosaceae. They are genus *Prunus.* The European plum is *P. domestica.* The Japanese plum is *P. salicina.* American plums include *P. americana, P. nigra,* and *P. besseyi.*

See also **Drupe; Prune; Fruit.**

**Plumage** is the overall feather covering of a bird. It insulates the bird against the extremes of cold and heat. Without plumage, birds would be unable to fly. For movement through the air, plumage also provides *streamlining* (a smooth, nonresistant shape). Streamlining also helps swimming, in such birds as cormorants and penguins. Many species of birds lose their feathers at least once a year through moulting, and replace them through regrowth.

Male birds often have more brightly coloured plumage than females, especially during the breeding season. Males use their plumage to attract a mate and to defend their territory. The plumage of female birds is usually more subdued, making them difficult to see when sitting on the nest.

The plumage of newly hatched birds is downy and provides extra insulation. Some young birds have plumage different from that of their parents. For example, it may be dull in colour or spotted to provide camouflage.

See also **Bird** (Feathers).

**Plumb line,** also called *plummet,* is a string or line with a weight attached to one end. The weight, called a *plumb bob,* keeps the line straight up and down. Plumb lines are used by bricklayers and stonemasons as vertical guides in building walls. Surveyors and engineers use plumb lines to set sighting instruments called *transits* over a specific point. Plumb lines are also used to determine the depth of water or of excavations. But today, crews on most ships use instruments called *fathometers* and *sonars* to measure the depth of the water.

See also **Surveying** (Surveying tools).

**Plumbago,** also called *leadwort,* is the name of about a dozen species of evergreen flowering shrubs and climbing plants. They are widely distributed. Several species are grown as garden or house plants. Plumba-

**Plumbago plants** are grown for their attractive flowers. This species is a climbing plant that originated in South Africa and is widely cultivated in greenhouses in other countries.

gos have handsome clusters of blue, white, or reddish-purple flowers. Each flower is shaped much like a phlox blossom. The flaring petals are joined at the centre to form a long tube. The leaves are also like those of the phlox. They are oval, shiny, and dark green.

**Scientific classification.** Plumbagos belong to the leadwort family, Plumbaginaceae. A common cultivated species from South Africa is *Plumbago capensis.*

**Plumbing** is a system of pipes that carries water into and out of a building. The term comes from the Latin word *plumbum,* meaning *lead.* The ancient Romans used lead pipes. Today, most plumbing pipes are made of brass, cast iron, copper, plastic, or steel.

A plumbing system consists of two separate sets of pipes, a *water supply system* and a *drainage system.* The water supply system brings clean water to baths, showers, sinks, and toilets, and to dishwashers, hot-water heaters, and washing machines. The drainage system carries away water and waste materials.

A building's plumbing must be both efficient and safe. Defects in a water supply system, such as leaking connections or dripping taps, can waste a large amount of water. A drainage system that leaks or overflows creates a health hazard by spilling waste materials and the bacteria they contain.

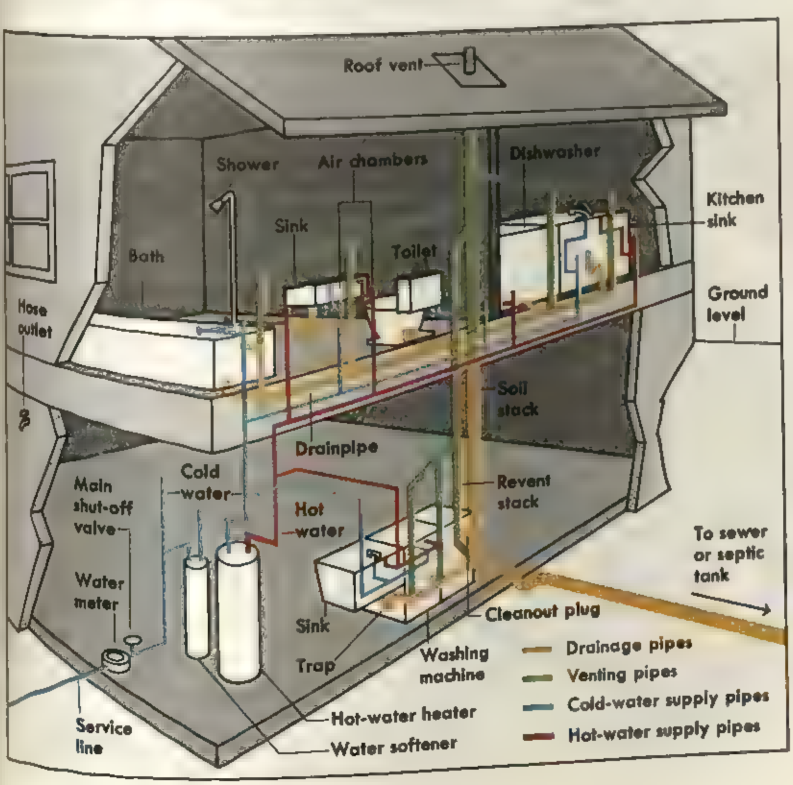
**The water supply system.** Water for a plumbing system comes from two sources: (1) rivers and lakes, and (2) wells and reservoirs. Cities and towns draw water from these sources and pipe it to treatment plants, where it is purified. The purified water flows through large pipes called *mains,* which run under the streets. The mains connect with smaller pipes known as *supply pipes,* which lead into each building. In some countries, houses and other buildings in rural and suburban areas have private wells. See **Water** (City water systems).

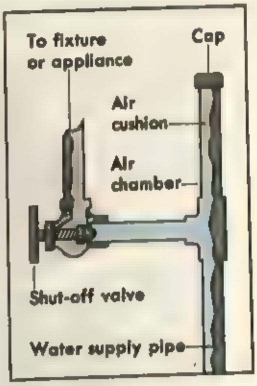
The water supply of every building has a *shut-off* valve. The shut-off valve normally remains open, permitting water to enter the building. The valve can be closed to turn off the water in order to repair the pipes or fixtures or in case of some other emergency. Each plumbing fixture and appliance also should have its own shut-off valve.

Within a building pipes distribute water to the various plumbing fixtures and appliances, each with a valve to hold back the water until it is needed. With a *direct* system, cold water is taken directly to all the cold taps, to appliances using cold water, and to a water heater which is powered by either gas or electricity. Heated water is piped from the top of the heater to the hot taps and to appliances that use hot water. As hot water is used, cold water flows in to the bottom of the heater to replace it. All the water in the system is at mains pressure, even when it is not running.

In an *indirect* system, cold water at mains pressure is piped to the cold tap at the kitchen sink to guarantee a pure supply for drinking and cooking. It is also piped to a high-level cold water storage tank. From there, water is distributed by *gravity* (natural flow) to other cold taps and appliances, and to a hot-water cylinder which is heated either directly by electricity or by a central heating system. Hot water is piped to feed the hot taps and is replaced by cold water from the storage tank.

**The drainage system.** After water has been used, it flows out of the building through the pipes of the drainage system. This system also carries away solid waste from sinks, toilets, waste disposal units, and other fix-




**All plumbing systems** have a water supply system and a drainage system. The water supply system brings clean water to plumbing fixtures and appliances. The drainage system has drainage pipes that carry away water and waste materials. Venting pipes keep air flowing through the system.

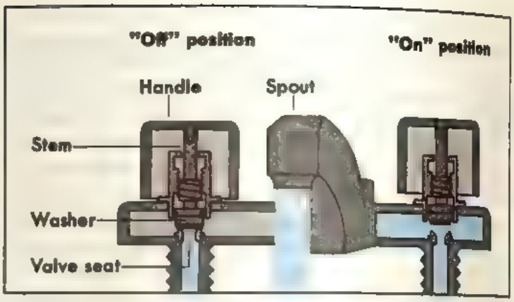
tures and appliances. The pipes of the drainage system are larger than the pipes of the water supply system in order to prevent them from becoming clogged with solid materials.

The drainpipes from the fixtures and appliances slant downward, carrying water and sewage to a vertical pipe called the *soil stack.* The soil stack empties into a main drain beneath the building. This drain leads to a sewer or septic tank outside the building. The top of the soil stack extends up through the roof of the building, where it is vented to the open air. The waste pipes from the various plumbing fixtures, including the toilets, connect directly into the soil stack, emptying through a U- or S-shaped bend called a *trap.* Water is held in the trap when the waste pipe is not being used, and this serves as an air-tight seal that prevents gases from the sewer or septic tank from entering the building. Instead, the gases escape through the soil stack.

Modern traps can be dismantled if the waste pipe becomes blocked. Older traps have a plug that can be removed so a long flexible tool called a *drain auger* can be inserted to clear the blockage. Clean-out points or *rodding eyes* are located at other points on the waste system. Access to the drainage system can be gained through in-ground inspection chambers called *manholes.*

In many communities, sewage flows from the main drain of each building into an underground system of pipes that carries it to a *sewage treatment plant.* The plant treats the sewage water and reduces the bacteria in it. The water can then be poured into a river or other body of water with minimum damage to the waterway.

Many rural and suburban areas do not have a public sewerage system. There, the sewage from a building



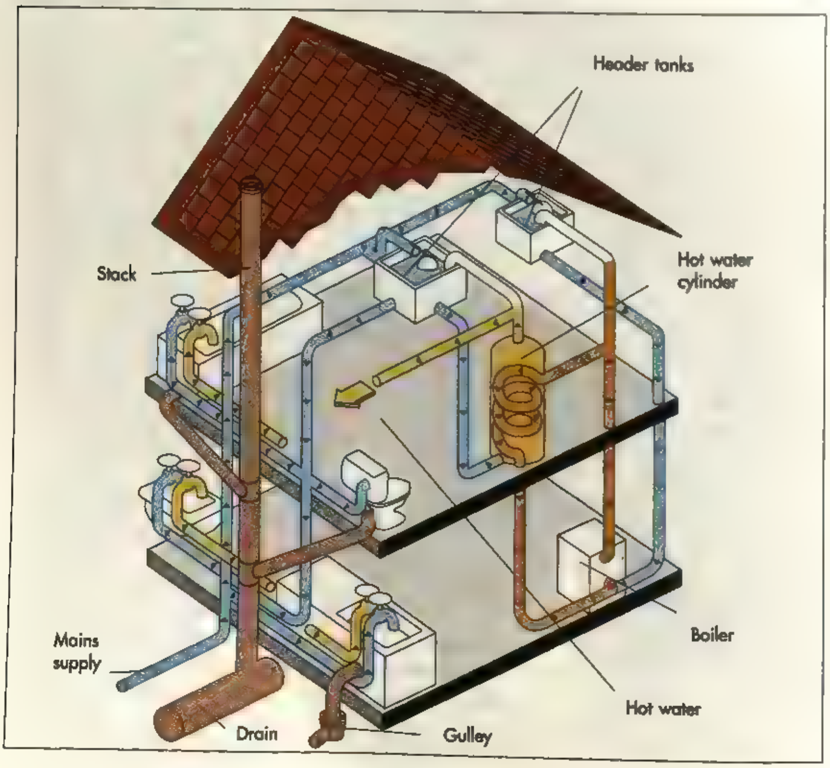

**A washer-type tap** has a threaded *stem* attached to each of its handles. At the bottom of each stem is a washer. When the water is turned off, the stem and washer are held tightly over a *valve seat* at the top of the water supply pipe. When the water is turned on, the stem and washer are held off the seat.

flows into a septic tank nearby. Bacteria in the septic tank break down most of the solids in the sewage into gas and a harmless substance called *humus.* The gas escapes into the air, and the humus is removed periodically. The liquids run out of the tank into the surrounding soil. See **Sewage.**

The flow of water is regulated by taps in baths, showers, sinks, and other principal kinds of plumbing fixtures except toilets. Toilets have cisterns filled by a device called a *ball valve* or *ball cock* or *float valve.*

**How taps work.** There are two main kinds of taps, *washer-type taps* and *washerless taps.* Most washer-type taps have two handles, one for hot water and one for cold. The water comes out of a single spout. Such taps are called *mixer taps.* Older washer-type taps have a separate handle and spout for hot and cold water.

In a washer-type tap, water is turned on and off by




**In a direct plumbing system,** cold water flows directly to cold taps and appliances, and also to a water heater from which hot water is distributed. In modern homes, all appliances usually discharge into a single soil stack, although the sink waste pipe may lead to a gully instead.

turning one or both of the handles. A threaded *stem* is attached to each handle and screws into the tap. At the bottom of each stem is a washer made of rubber or of synthetic fibres. When the tap is turned off, the stem and washer are held tightly over a *valve seat* at the top of the water supply pipe. The washer prevents the flow of water into the tap. When the tap is turned on, the stem is unscrewed enough to lift it and the washer off the seat. Water can then flow into and through the spout.

Washerless taps have either two handles or one, and most have a single spout. In a washerless tap with two handles, water is turned on and off the same way as in washer-type taps. In most single-handle washerless taps, water is turned on by lifting the handle and is turned off by pressing the handle down. The temperature of the water is regulated either by turning the handle or by moving it from side to side.

Attached to the handle of a typical washerless tap is a disc or some other device with several holes in it. This disc fits over another disc. The two discs have the same number of holes, and all the holes are the same size. When the tap is turned off, the position of the top disc changes so that the disc covers the holes of the bottom disc. Water cannot flow into the tap when the top disc is in this position. When the tap is turned on, the holes of the two discs are lined up with one another, enabling water to flow through them and into the spout.

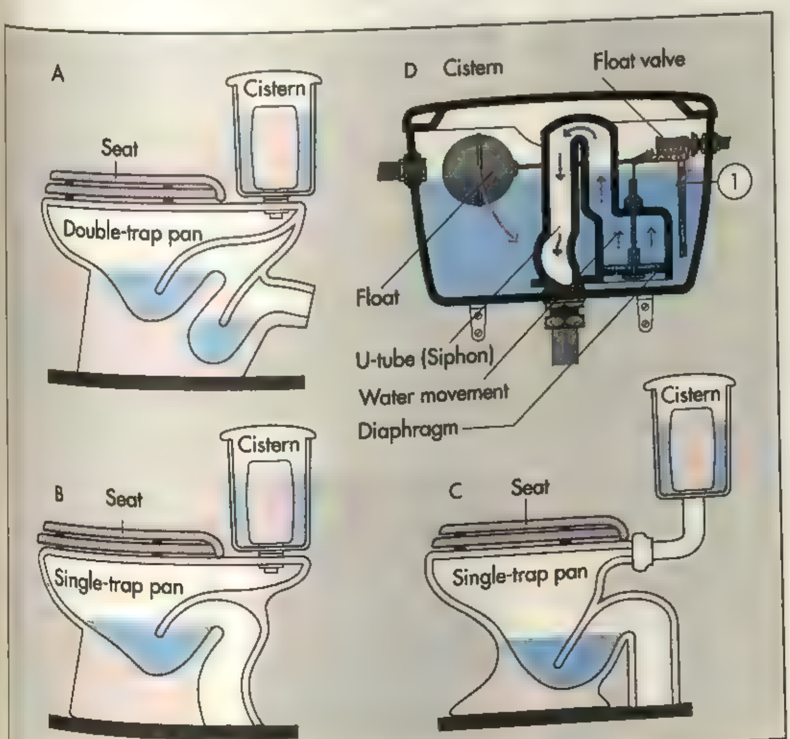
**How toilets work.** Most toilets consist of a *pan* and a *cistern,* both of which contain water. When a toilet is flushed, water rushes from the cistern through a *discharge opening* and into the pan. The rushing water carries the contents of the pan through the trap of the toilet to the soil stack. The pan and cistern refill with water from a water supply pipe, and the toilet is then ready to be flushed again.

Modern toilets have either a low-level or close-coupled cistern. A low-level cistern is sited with its base just above the top of the pan and is connected to it by a short discharge pipe. A close-coupled cistern is set on the back of the pan and discharges directly into it. The flow of water into the cistern is controlled by a float valve, which opens to refill the cistern when the toilet is flushed and closes when the cistern is full again.

**History.** The earliest plumbing systems were developed to dispose of human wastes. In the Indus Valley in what are now Pakistan and western India, most dwellings had drains for waste disposal by about 2500 B.C. A palace built on the island of Crete in about 2000 B.C. had pipes that supplied drinking water. The ancient Romans developed taps and a sewerage system that carried waste into rivers and streams.

The quality of plumbing declined after the fall of the Roman Empire in A.D. 476. During the Middle Ages, people disposed of waste materials by throwing them into the street. A type of flush toilet was developed in the 1500's. However, it did not come into wide use because of the general lack of plumbing and sewerage systems. In 1778, Joseph Bramah, an English cabinetmaker, patented an improved flush toilet. During the first half of the 1800's, toilets became common in England. But most of them drained into pits called *cesspools,* which often overflowed. Septic tanks were invented in the mid-1800's, and a modern sewerage system began operating in London in the 1860's.

**Plunkett, Edward John Moreton Drax.** See Dunsany, Lord.




**Toilets** vary greatly in design throughout the world. The diagram on the left shows: (A)—a close-coupled cistern and double-trap pan; (B)—a close-coupled cistern and single-trap pan; (C)—a low-level cistern and single trap pan; and (D)—a cross-sectioned cistern. Pulling a lever down (1) raises a diaphragm which starts water siphoning up and over an inverted U-tube and into the pan. As the water level in the cistern falls, the float descends and opens the float valve or ball cock, causing water to enter and refill the cistern. The siphon action stops when the cistern is nearly empty.

**Plunkett, Sir Horace Curzon** (1854-1932), was a pioneer of the cooperative farming movement in Ireland. He was a Protestant and a landlord. He commanded the respect of the Irish Roman Catholics for his enlightened views on land reform and social policy. In 1894, he founded the Irish Agricultural Organization Society. By 1898, it had branches in every county in Ireland. Plunkett was born at Sherborne House, in Gloucestershire, England. He was educated at Eton College and Oxford University. Plunkett served as a member of Parliament from 1892 to 1900 and was a senator in the Irish Free State Government in 1922 and 1923. Plunkett was elected a Fellow of the Royal Society in 1902, and in 1903 he was knighted.

**Sir Horace Plunkett**

**Plunkett, Saint Oliver** (1625-1681), was Roman Catholic archbishop of Armagh and primate of Ireland from 1669 until his death. Plunkett, like many other Roman Catholics in England and Ireland, was severely persecuted during the Popish Plot, and, in 1678, was arrested. In July 1681, he was hanged, drawn, and quartered at Tyburn. The Roman Catholic Church beatified him in 1920. He was canonized in 1975 (see **Canonization**). Plunkett was born in Meath, Ireland, and educated in Rome. See also **Popish Plot**.

**Plural.** See **Number** (in grammar).

**Pluralism.** See **Government** (Pluralism); **Minority group**.

**Plutarch** (A.D. 46? - A.D. 120?), a Greek biographer and essayist, became famous for his work, *Parallel Lives of Illustrious Greeks and Romans*. Plutarch wrote the *Lives*, or biographies, in pairs of one Greek and one Roman statesman or general. The comparisons are often forced, but the *Lives* constitute an important source of historical information.

*Plutarch's Lives* became the basis of many stories and poems of the Middle Ages. William Shakespeare and other Elizabethan dramatists used a brilliant translation of the *Lives* by Sir Thomas North for material for many of their historical plays. The *Lives* contains sharply drawn character sketches and lively historical descriptions of Greece and Rome.

Among Plutarch's other writings are his *Morals*. They include essays on historical, religious, and philosophical topics. Among them is a curious account of *The Face on the Moon*.

Plutarch was born in Chaeronea, in Boeotia, Greece, near the homes of Hesiod and Pindar. He studied philosophy in Athens and later lectured on this subject in Rome. In travels through Greece, Italy, and Egypt, he spent much time studying and collecting facts on the men of whom he wrote. He returned to Chaeronea as a priest of Apollo, and it is believed that he wrote his great works there.

**Pluto** is usually the most distant planet from the sun. Pluto and Neptune are the only planets that cannot be seen without a telescope. Astronomers "discovered" both these planets by using mathematics.

**Pluto at a glance**

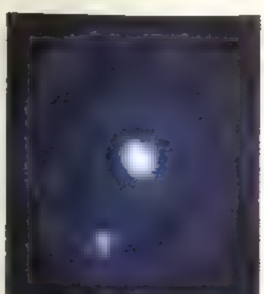
**Distance from the sun:**
*Shortest*—4,425,100,000 kilometres;
*Greatest*—7,375,100,000 kilometres;
*Mean*—5,900,100,000 kilometres.
**Distance from the earth:**
*Shortest*—4,290,000,000 kilometres;
*Greatest*—7,520,000,000 kilometres.
**Diameter:** 2,300 kilometres.
**Length of year:** About 248 earth-years.
**Rotation period:** About 6 earth-days.
**Temperature:** About −233 °C to −223 °C.
**Atmosphere:** Methane.
**Satellites:** 1.

Pluto is about 39 times as far from the sun as Earth is. Its mean distance from the sun is about 5,900,100,000 kilometres. Pluto travels around the sun in an *elliptical* (oval-shaped) orbit. At some point in its orbit, it comes closer to the sun than Neptune, usually the second farthest planet. It remains inside Neptune's orbit for about 20 earth-years. This event occurs every 248 earth-years, which is about the same time it takes Pluto to travel once around the sun. Pluto entered Neptune's orbit on Jan. 23, 1979, and will remain there until March 15, 1999.

As it orbits the sun, Pluto spins on its axis, an imaginary line through its centre. It spins around once in about six earth-days.

Astronomers know little about Pluto's size or surface conditions because it is so far from Earth. Pluto has an estimated diameter of about 2,300 kilometres, less than a fifth that of Earth. Pluto's surface is one of the coldest places in our solar system. Astronomers believe the temperature on Pluto may be about −233 °C to −223 °C. The planet appears to be partly covered with frozen methane gas and to have a thin atmosphere composed mostly of methane. Because Pluto's density is low, astronomers think Pluto is mainly icy. Scientists doubt that Pluto has any form of life.

In 1905, Percival Lowell, an American astronomer, found that the force of gravity of some unknown planet seemed to be affecting the orbits of Neptune and Uranus. In 1915, he predicted the location of a new planet, and began searching for it from his observatory in Flagstaff, Arizona, U.S.A. Lowell used a telescope to photograph the area of the sky where he thought the planet would be found. He died in 1916 without finding it. In 1929, Clyde W. Tombaugh, an assistant at the Lowell Observatory, used predictions made by Lowell and other astronomers and photographed the sky with a more powerful, wide-angle telescope. In 1930, Tombaugh



**Pluto's** vast distance from earth makes it impossible to see without a telescope. In 1990, the orbiting Hubble Space Telescope took the first photo, *left*, that clearly shows Pluto and its satellite, Charon.

found Pluto's image on three photographs. The planet was named after the Roman god of the lower world.

In 1978, astronomers at the U.S. Naval Observatory substation in Flagstaff detected a satellite of Pluto. They named it Charon. This satellite has a diameter of about 1,200 kilometres. Astronomers have improved their measurements of Pluto's diameter and density by studying mutual eclipses of Pluto and Charon.

In September 1990, the Hubble Space Telescope took the first clear photographs of Pluto and Charon. In previous photographs taken by ground-based telescopes, the planet and satellite appeared together as one uneven point of light. The Hubble telescope photographs showed them as separate objects.

See also **Planet**; **Solar system**.

**Pluto** was the god of the dead in Roman mythology. The Romans sometimes called him *Dis Pater* or *Orcus*. Pluto was almost identical to Hades, the Greek god of the dead. The Romans borrowed and preserved without change almost all the myths about Hades and his underworld kingdom. Some scholars believe the Romans had no god of the dead before they encountered Greek culture in the 700's B.C. The name *Pluto* comes from *Pluton*, an alternative Greek name for Hades.

See also **Hades**; **Persephone**.

**Plutonium** is a chemical element with the symbol Pu. It is a radioactive metal. Almost all plutonium is produced artificially. Only an extremely small amount of it occurs naturally. The atomic number of plutonium is 94. Plutonium melts at 640 °C and boils at 3460 °C. At 20 °C, plutonium has a density of 19.86 grams per cubic centimetre (see **Density**).

Plutonium is highly poisonous because it rapidly gives off radiation in the form of high-energy particles called alpha particles (see **Alpha particle**). These particles may cause cancer or other serious health problems. In addition, plutonium is extremely explosive. It must be kept in quantities smaller than a *critical mass*, the amount at which it would explode spontaneously.

Scientists have discovered 15 isotopes of plutonium. These isotopes have mass numbers 232 to 246. The most important isotope is Pu-239, which readily undergoes *fission* when struck by a neutron. In the fission process, the nucleus of an atom is split into two nearly equal parts, and energy is released. Pu-239 is a source of energy in nuclear reactors. It is also used in nuclear weapons. Scientists produce Pu-239 by bombarding uranium 238 with neutrons. The same process forms Pu-239 as a waste product in nuclear reactors that use uranium as the basic fuel. The disposal of waste Pu-239 has become a serious problem because of its relatively long *half-life* of 24,100 years (see **Radioactivity** [Half-life]).

Plutonium has various other applications. For example, Pu-238 powers heart pacemakers, certain instruments on spacecraft, and some other devices. Pu-242 and Pu-244 are useful in studying chemicals and metals.

Plutonium was discovered in 1940 by four American scientists—Glenn Seaborg, Edwin McMillan, Joseph Kennedy, and Arthur Wahl. They produced Pu-238 by bombarding uranium 238 with *deuterons*, the nuclei in atoms of *deuterium*, an isotope of hydrogen. The most stable plutonium isotope, Pu-244, was discovered in nature in 1971.

See also **Nuclear energy**; **Transuranium element**.

**Plymouth** (pop. 238,800) is a seaport in Devon, on the southwest coast of England. It is also a local government district. It lies on Plymouth Sound, where the River Tamar flows into the English Channel. Local industries include shipbuilding, and a variety of electronics and related businesses. Tourism is also important.

According to tradition, Sir Francis Drake played bowls on Plymouth Hoe before defeating the Spanish Armada in 1588. Plymouth was the last port touched by the *Mayflower*, the ship that carried the Pilgrim Fathers to North America, in 1620 (see **Mayflower**). The city was badly damaged by bombing during World War II.

See also **Devon**.

**Plymouth Brethren** are members of a small Christian sect. They emphasize the importance of the Bible and lead simple lives. They have no organized ministry. The sect originated in Dublin, Ireland, in 1828 and became prominent at Plymouth, England, several years later. In 1849, the sect split into two groups, the Open Brethren and the stricter Exclusive Brethren.

**Plymouth Colony.** See **Pilgrim Fathers**.

**Plywood** is a building material usually made of an odd number of thin layers of wood glued together. The layers, called *plies* or *veneers*, are arranged so that the *grain direction* (direction of the wood fibres) of each layer is at right angles to that of the layer next to it. The outside plies are called *faces* and *backs*, and the centre ply or plies are called the *core*. The simplest plywood is made of three plies. However, five, seven, or more plies may be used. In some cases, plywood may have an even number of plies, with the grain direction of the two centre plies being parallel. The term *plywood* is also used for panels that have a solid timber core up to 7.5 centimetres thick. These panels are used for doors.

**Use of plywood.** The chief advantage of plywood is that by gluing together an odd number of plies of veneer, a material that is lightweight and workable, yet strong and rigid, can be obtained. Plywood can also be cut to exact sizes and produced in large panels for ease of application, strength, and smooth surfaces. It shrinks and swells less than ordinary wood, and has greater resistance to splitting at the ends. This permits carpenters to fasten plywood sheets with nails or screws close to the edges. Plywood also has little or no tendency to warp or twist. Expensive woods can be used for the faces because only thin sheets are needed.

**Kinds of plywood.** Plywood is classified by material and by use. The materials are classified as hardwood and softwood. Most *softwood* plywood is made of Douglas fir or southern pine. But western hemlock, white fir, ponderosa pine, redwood, and many other trees are used. *Hardwood* plywood is available in over 80 kinds of wood. They include woods such as oak, red gum, poplar, birch, cherry, walnut, and mahogany and other attractive tropical woods.

*Interior* plywood is usually made with glues that are moisture-resistant. *Exterior* plywood is designed to withstand severe conditions resulting from moisture and humidity. It is always made with waterproof glues.

**Making plywood** is done in three steps.

*Logs* used for plywood are selected for straightness, roundness, and freedom from knots and decay. After the bark is removed and the logs are cut to the desired lengths, they are often steam-heated. This softens their

surfaces, and they are placed into a lathe or slicer to be converted to veneer (see **Veneer**).

*Veneer* is made in one of three ways. These are (1) sawing, (2) slicing, or (3) rotary cutting. *Sawing* is used only for fine finishing woods, such as ebony or knotty pine, which are too brittle or unsuitable for slicing. *Slicing* is used chiefly for fine-figured woods for furniture or wall-panel faces. Slicing is done by moving the log, called a *flitch*, against a heavy, stationary knife.

**Plywood**

About nine-tenths of veneer is *rotary cut* with a lathe. The log is placed in a lathe and then rotated against a stationary knife extending across its length. The veneer is then unwound in a long, continuous ribbon.

*The lay-up* takes place after the plies are dried, trimmed, and matched. A thin layer of glue is applied to each ply. Workers then *lay-up*, or place, the plies with the grain in each ply opposite to that in the adjacent ply. Giant hydraulic presses squeeze the plies together with heat and pressure, or pressure only. Then the finished plywood is again dried, trimmed, sanded, or otherwise finished into sheets.

See also **Finland** (Manufacturing); **Laminating.**

**Plzeň** (pop. 174,555) is an important city in Bohemia, a region in the Czech Republic. The city is also called Pilsen. It stands at the junction of two rivers, the Mže and the Radbuza (see **Czech Republic** [political map]). Plzeň was a Roman Catholic stronghold in the days of the religious wars, and withstood many sieges. The city is the home of the Skoda factory, which makes military equipment and motor vehicles. Plzeň breweries produce world-famous Pilsner beer.

See also **Czech Republic.**

**P.M.** See **Hour.**

**Pneumatic tool** is a power implement operated by compressed air. Pneumatic tools have various uses. For example, dentists use air-powered drills to remove tooth decay. Car mechanics use pneumatic wrenches to tighten nuts and bolts. Construction workers use pneumatic hammers to break up pavement.

The air for pneumatic tools is supplied by a machine called an *air compressor*. The compressor squeezes together air molecules, usually to a pressure of about 700 kilopascals. The air drives the tool in either a *reciprocating* (back and forth) motion or a *rotary* (circular) motion.

Reciprocating motion is used in jackhammers, riveting tools, ramming tools, and digging tools. In these tools, compressed air causes a piston to move back and forth inside a cylinder. The piston then pushes against a striking device at the end of the tool. A small jackhammer can deliver from 2,000 to 3,000 blows per minute.

Rotary motion is used in power drills, power wrenches, grinders, and sanders. Such tools have a *rotor*, which has several blades. The rotor spins as compressed air is forced against each blade in turn. As the rotor spins, it turns a shaft that is connected to a device for drilling, grinding, or other rotary action. Thousands of rotations may occur per minute. The high speed of the rotations causes the high-pitched noise that comes from a dentist's drill, the turbines in a jet engine, and other rotating pneumatic machinery.

**Pneumatic tools,** like the pneumatic hammer above, are operated by compressed air.

**Pneumatics** is the branch of physics that studies the properties of gases, especially air. Engineers apply pneumatics in the design of tools and machines that take advantage of these properties.

See also **Gas** (matter); **Pneumatic tool; Pump.**

**Pneumoconiosis.** See **Black lung.**

**Pneumonia** is a lung disease characterized by inflammation. Almost all cases of pneumonia result from infection by viruses, bacteria, fungi, or other microbes. A few cases are caused by allergic reactions or by inhaling irritating chemicals. This article discusses pneumonia caused by viruses and bacteria.

Before the development of antibiotic drugs during the 1940's, pneumonia killed about a third of its victims. Today, with proper medical treatment, more than 95 per cent of pneumonia patients recover. Pneumonia is still among the leading causes of death in some countries.

People with other serious health problems have the greatest risk of getting pneumonia, and they also have the most difficulty recovering from it. Conditions that increase the risk of pneumonia include emphysema, heart disease, alcoholism, and various diseases that weaken the body's resistance to infection. Children and elderly people have a greater risk of getting pneumonia.

**How pneumonia develops.** In most cases, a person gets pneumonia by inhaling small droplets that contain harmful viruses or bacteria. These droplets are sprayed

into the air when an infected person coughs or sneezes. Many cases of pneumonia result when bacteria that are normally present in the mouth, nose, and throat invade the lungs. The body's defence mechanisms ordinarily prevent these bacteria from reaching the lungs. If the defences weaken enough, severe pneumonia may develop. Such infections occur most commonly among patients who are hospitalized for other illnesses.

A wide variety of viruses cause pneumonia, including some of the same ones responsible for influenza and other respiratory infections. Many types of bacteria also cause pneumonia. But most cases of bacterial pneumonia result from infection by bacteria called *pneumococci*, also known as *Streptococcus pneumoniae*. A bacterium called *Mycoplasma pneumoniae* causes another common type of pneumonia, which occurs mainly among children and young adults.

In the lungs, microbes that cause pneumonia lodge in the air sacs, where the blood normally exchanges carbon dioxide for oxygen. There they multiply rapidly, and the air sacs soon fill with fluid and with white blood cells produced by the body to fight infection.

**Symptoms and diagnosis.** The symptoms of pneumonia vary with the type of microbe involved and the patient's general health before the onset of the disease. In general, the symptoms of bacterial pneumonia are more severe and begin more suddenly than those of viral pneumonia. Most cases of bacterial pneumonia start with a sudden attack of chills, high fever, and chest pain. The patient also develops a painful cough, which is dry at first but later produces brown *sputum* (mucus and other substances from the lungs). Most cases of viral pneumonia are mild. The symptoms include fever, weakness, cough, and production of sputum.

**Treatment and prevention.** In the treatment of all types of pneumonia, complete bed rest is essential until at least two or three days after the fever ends. For viral pneumonia, there is no other specific treatment. Most cases clear up by themselves within a period of a few days to a few weeks. In treating bacterial pneumonia, doctors use antibiotics. Penicillin works best in cases caused by pneumococci, but other antibiotics are more effective against other types of bacteria.

Influenza vaccinations protect against pneumonia caused by influenza viruses. Another vaccine protects the body from pneumonia caused by pneumococci. However, doctors recommend it only for elderly people, patients with a long-term illness, and other people who have a high risk of catching pneumonia.

See also **Legionnaires' disease**.

**Pneumothorax** is air or gas in the space between the lungs and the chest wall. A thin, continuous membrane called the *pleura* covers the outside of the lungs and the inside of the chest wall (see **Pleura**). Normally, the part of the pleura covering the lungs lies close to the part on the inside of the chest. Only a very thin film of liquid separates the two parts. Ordinarily, no air is present in the space between them. If air or gas enters the pleural space, the two sections of membrane are pushed apart. When a large amount of air or gas collects between the parts of the pleura on one side of the chest, the lung on that side cannot fully expand. Breathing becomes difficult, and the lung may even collapse.

Pneumothorax may result from a wound in the chest, such as a knife or gunshot wound, or after a sudden tear in the lung. Infection of the pleural space by gas-producing microbes can also cause pneumothorax. Doctors treat pneumothorax by removing the gas by suction, surgically repairing the chest or lung, or prescribing antibiotics when an infection is present.

**Pnom Penh.** See **Phnom Penh**.

**Po River** is the largest waterway in Italy. The Po begins near Monte Viso, in the Cottian Alps, and flows in an easterly direction about 652 kilometres to a large delta in the Adriatic Sea. Almost every river in northern Italy is a branch of the Po. Lakes Maggiore, Como, Lecco, Iseo, and Garda also empty their waters into the Po. The river is rapid in its upper courses, but becomes a sluggish stream long before it reaches the sea. The Po River has often caused disastrous floods. About 300 B.C. the Etruscans built artificial embankments in an effort to control the waters. The river's continual deposits of silt raise the level of the water. From time to time, the embankments have been raised to heights above the river. For location, see **Italy** (physical map).

Some of Italy's large cities lie on the banks of the Po, including Turin, Piacenza, and Cremona. Large electric power plants operate along the upper sections of the river. Large ships can sail up the Po as far as Turin.

See also **Italy** (The Po Valley).

**Pocahontas** (1595?-1617) was the daughter of the American Indian chief, Powhatan. She worked to maintain friendly relations between the Indians and early English colonists in America. Captain John Smith, the leader of the settlers in Jamestown, Virginia, claimed that she saved his life. Powhatan was about to kill him, but the 12 year-old Pocahontas, Smith claimed, placed her head upon his and begged her father to spare him.

William Strachey wrote that Pocahontas married a chief from her tribe when she was about 14 years old. By 1608, fighting had broken out between the white settlers and Powhatan's Indians. Pocahontas was lured on board an English ship in 1613 and held captive. There she met settler John Rolfe and was converted to Christianity. She married Rolfe in 1614.

Pocahontas went with her husband to London in 1616 to raise funds for the settlers and was presented to the court of King James I. She died of smallpox while waiting to sail back to America.

**Podgorny, Nikolai Viktorovich** (1903-1983), served as president, or officially as chairman, of the Presidium of the Supreme Soviet, from 1965 to 1977. The Presidium handled legislative matters between sessions of the Supreme Soviet, the Soviet Union's legislature. Podgorny also was a member of the policymaking Politburo of the Communist Party's Central Committee from 1960 to 1977.

Podgorny was born in Karlovka, in Ukraine. He joined the Communist Party in 1930. In 1931, he graduated from a food institute in Kiev. He worked in various administrative posts in the food industry from 1931 to 1946. The Kharkov regional party committee in Ukraine appointed him first secretary in 1950. Podgorny also served as first secretary of the Ukrainian Communist Party from 1957 to 1963.

**Podzol** is a type of soil that is commonly found in coastal areas and cooler regions of Australia and New Zealand. The name comes from the Russian words

meaning *ashes underneath,* which refer to the ashen grey *horizon* (layer) immediately beneath the organic topsoil.

In Australia, these soils only occur in sandy areas or where the climate allows just the right rate of leaf litter decomposition.

**Poe, Edgar Allan** (1809-1849), was a great American poet, short-story writer, and literary critic. "The Raven" is one of the best-known poems in American literature, and an example of the haunting quality of many of Poe's works. With "The Murders in the Rue Morgue" and other short stories, Poe became the founder of modern mystery and detective fiction. "The Fall of the House of Usher," "The Masque of the Red Death," and other such tales made him a forerunner of symbolism, impressionism, and the grotesque in modern literature. "The Poetic Principle," the "Marginalia," and his reviews contain important principles of literary criticism, which, together with his poetry and fiction, influenced many later writers.

**Poe's life.** Poe was born in Boston, Massachusetts. His father deserted the family and his mother died before Poe was three years old. John Allan, a tobacco exporter in Richmond, Virginia, and his wife Frances raised Poe as a foster child. In 1827, Poe left home for Boston.

Poe's literary career began with two volumes of poetry, *Tamerlane and Other Poems* (1827) and *Al Aaraaf, Tamerlane, and Minor Poems* (1829). *Poems* (1831) included three of his best works—"To Helen," "The City in the Sea," and "Israfel." His first five short stories were published in 1832. In 1833, Poe started work for the *Southern Literary Messenger.* He moved to New York City in 1837.

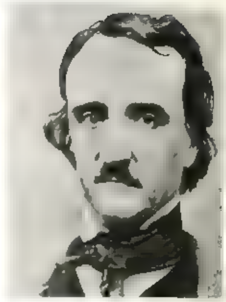
Poe's most productive period as a fiction writer and critic extended from 1837 to 1845. He spent the first 18 months in New York City. Poe then moved to Philadelphia in 1838, and edited two magazines there. In Philadelphia, Poe wrote significant reviews of the works of Longfellow and Hawthorne. Some of his greatest tales appeared in a collection of his first 25 stories, *Tales of the Grotesque and Arabesque* (1840).

From 1844 until his death, Poe lived in New York City. During the mid-1840's, he enjoyed a growing reputation as a short-story writer. His tale "The Gold-Bug" (1843) sold 300,000 copies. In many ways, 1845 was his best year—12 stories published in *Tales* and 30 poems in *The Raven and Other Poems.* "The Raven" brought him his greatest recognition.

**Poe's works.** Poe's most popular fictional tales are filled with the strange, the bizarre, and the terrible. He insisted that these tales of terror were expressions of psychological and moral realities. Many of Poe's stories subtly present the theme of moral responsibility.

For example, "The Fall of the House of Usher," perhaps Poe's best story, concerns the twins Roderick and Madeline Usher. When Madeline falls into a trance, Roderick buries her in a deep vault, thinking she is dead. Poe means that people cannot separate vital self from intellect without being destroyed.

Poe wrote of the inhumanity of people in "The Pit and the Pendulum," the dark and silent indifference of the universe in "Shadow" and "Silence," and the triumph of time and death over human folly and pride in "The Masque of the Red Death."



Edgar Allan Poe

"The Raven" is Poe's best-known poem and one of the most famous works in American literature. The theme of "The Raven" is the narrator's grief over the loss of an ideal love. This poem has a dramatic intensity that makes the hypnotic monotony of rhythm and tone a realistic reflection of the speaker's state of mind.

Poems such as "To Helen," "Ulalume," and "For Annie" are noted for their subtle use of rhyme, rhythm, symbols, and psychology. They show Poe's ability to use rhythmic and tonal qualities that reinforce ideas and subconscious feelings.

Poe's critical thought was influenced by his career as a magazine journalist. From 1844 to 1849, Poe published a number of jottings and short essays in various journals. These "Marginalia," as well as scattered reviews and letters, contain some of Poe's basic ideas on the nature of people, society, democracy, reform, and literature. "The Poetic Principle," first a lecture and then an essay published in 1850, best states Poe's ideas of poetry.

**Poem.** See Poetry.

**Poet laureate** is the official poet of a state or nation, especially the United Kingdom. Since the Middle Ages, many English poets have been called *laureates.* But Ben Jonson is regarded as the first poet laureate in the modern sense of the term. He, and after him Sir William Davenant, both received royal pensions and the unofficial honour of poet laureate. Since 1668, the poet laureate has been officially appointed by the king or queen to serve for life. To honour special occasions, the poet laureate writes a formal poem or ode. Many states in the United States have poet laureates. In 1985, the United States Congress authorized naming a poet laureate for the entire nation.

**Poets laureate of the United Kingdom**

| Name | Born | Appointed | Died |
|---|---|---|---|
| * **Ben Jonson** | 1572 | 1616 | 1637 |
| * **Sir William Davenant** | 1606 | 1638 | 1668 |
| * **John Dryden** | 1631 | 1668 | 1700 |
| **Thomas Shadwell** | 1642? | 1688 | 1692 |
| **Nahum Tate** | 1652 | 1692 | 1715 |
| **Nicholas Rowe** | 1674 | 1715 | 1718 |
| **Laurence Eusden** | 1688 | 1718 | 1730 |
| * **Colley Cibber** | 1671 | 1730 | 1757 |
| **William Whitehead** | 1715 | 1757 | 1785 |
| **Thomas Warton** | 1728 | 1785 | 1790 |
| **Henry James Pye** | 1745 | 1790 | 1813 |
| * **Robert Southey** | 1774 | 1813 | 1843 |
| * **William Wordsworth** | 1770 | 1843 | 1850 |
| * **Alfred, Lord Tennyson** | 1809 | 1850 | 1892 |
| **Alfred Austin** | 1835 | 1896 | 1913 |
| * **Robert Bridges** | 1844 | 1913 | 1930 |
| * **John Masefield** | 1878 | 1930 | 1967 |
| * **Cecil Day-Lewis** | 1904 | 1968 | 1972 |
| * **Sir John Betjeman** | 1906 | 1972 | 1984 |
| * **Ted Hughes** | 1930 | 1984 | |

*Has a separate biography in *World Book.*

Duomo, Florence/Bridgeman Art Library

**Dante Alighieri** was one of the most important medieval poets. This painting, by Domenico de Michelino (1417-1491), depicts Dante with scenes from his great poem *The Divine Comedy.*

# Poetry

**Poetry** is an arrangement of words in patterns of sound and meaning. Poems can combine patterns of rhythm with images to create beautiful or powerful impressions. Poetry shapes ideas, thoughts, and feelings in special ways. The English poet William Blake (1757-1827) wrote "The Sick Rose" some 200 years ago:

O Rose, thou art sick!
The invisible worm
That flies in the night
In the howling storm,

Has found out thy bed
Of crimson joy,
And his dark, secret love
Does thy life destroy.

This poem has a simple rhyme scheme and uses straightforward language, but the images create a sensation of strangeness. Blake takes the idea of a rose being attacked by a worm, a common occurrence in gardens. But his use of language changes this into a sinister happening. Blake speaks directly to the rose in this poem and describes the worm as a kind of vampire lover. He uses very few words to paint his word pictures, but he places each one carefully for maximum effect. The first line tells us plainly about the sickness of the rose and the last word we read is "destroy."

A poem can be either written or oral and can vary in length from a few words to thousands of pages. Some poems rhyme, and children often begin to learn about poetry through the simple, regular rhythms of nursery rhymes.

Since prehistoric times, people have created poetry in the form of songs, prayers, spells, riddles, and chants. In many societies, poets have been storytellers or historians, passing on tales about great events and people from generation to generation. The great epic poems of India, Central Asia, and northern Europe recorded the history of their own people.

The tradition of oral poetry is still very strong in many parts of the world today. Sometimes the poet is close to being a priest or shaman because he or she knows the secrets of a people or tribe, while at other times the poet is an entertainer who performs at important social events. Music and poetry have always been closely linked, and many singers who write their own songs are also respected poets.

As writing developed, poetry became an important art and individuals were able to write their own poems in private. This gave poets new possibilities, and enabled them to write about intimate, personal affairs, such as love, death, religious faith, grief, anger, and other powerful emotions. Today, millions of people read, write, and listen to poetry.

### Kinds of poetry

Through the years, poets have developed many kinds of poetry. The three main kinds are (1) lyric, (2) narrative, and (3) dramatic.

**Lyric poetry** is the most common type of poetry. The word *lyric* comes from *lyre,* a harplike instrument played by ancient Greek poets during recitals of shorter poems. Today, lyric poetry means any short poem.

The *haiku,* a Japanese form, is one of the shortest types of lyric poetry. In Japanese, the haiku consists of


Library of Congress, Washington Bridgeman Art Library

**William Blake** illustrated his poems with his own hand-coloured engravings. Blake published "The Sick Rose" in *Songs of Innocence* (1789).

17 syllables arranged in three lines. The first line has 5 syllables, the second 7, and the third 5. Some English translations of haiku try to capture their effect rather than imitate their form. The following translation by the Australian poet Harold Stewart of a haiku by the Japanese poet Issa has two lines of 10 syllables each:

> In these degenerate latter days, I stare
> Astounded: cherry-blossoms everywhere!

"Transformed Land" by Issa from *A Chime of Windbells*, compiled by Harold Stewart. Reprinted with permission of the Charles E. Tuttle Company, Incorporated, of Tokyo.

Other lyric forms are longer and more complicated than the haiku. The *ode* is a serious, elaborate lyric full of high praise and noble feeling. Many odes mark important public events. The *classical ode,* also called the *Pindaric ode* or *choral ode,* was developed by the ancient Greeks. It consists of three parts. The first two parts, the *strophe* and *antistrophe,* have the same pattern of rhyme. The third part, the *epode,* has a different pattern. Most odes that were developed later consist of stanzas with the same pattern of rhythm and rhyme.

The *elegy,* another common lyric, is a meditation on life and death. Many elegies mourn the death of a famous person or a close friend. The *sonnet* is a 14-line lyric with a certain pattern of rhyme and rhythm. Many sonnets are love poems. Other lyric forms include the *limerick, rondel, triolet,* and *villanelle.* For descriptions of these forms, see the table *Terms used in poetry.*

**Narrative poetry** tells stories. There are two chief kinds of narrative poems: (1) epics and (2) ballads.

***Epics*** are long poems. Most epics describe the deeds of heroes in battle or conflicts between human beings and natural and divine forces. Many other epics tell of the origin or history of a people. Epics are probably the oldest surviving form of poetry. Many scholars believe that the *Iliad* and the *Odyssey,* two of the most famous epics in Western literature, were composed during the 700's B.C. These works are traditionally attributed to the Greek poet Homer. The *Iliad* describes events in the last year of the Trojan War, which was fought between Greece and the city of Troy. The *Odyssey* tells of the adventures of Odysseus, king of Ithaca, on his return home after having fought for Greece in the Trojan War.

***Ballads*** tell shorter stories about a particular person. For example, many ballads in English literature describe the adventures of Robin Hood, a legendary outlaw who stole from rich people and gave to the poor. Some ballads date from the 1300's.

**Dramatic poetry,** like narrative poetry, tells stories. But in dramatic poetry, the poet lets one or more of the story's characters act out the story. Many plays are written as dramatic poetry. The difference between drama and dramatic poetry is a matter of degree. If the dialogue of a play rhymes, has repeating rhythms, or features other distinct poetic elements, the play is considered to be dramatic poetry. The English playwright William Shakespeare is the most famous dramatic poet.

In the *dramatic monologue,* the story is told in the words of only one character. Robert Browning, an English poet of the 1800's, wrote many poems in this style.

## The elements of poetry

**Rhythm and metre.** The word *rhythm* comes from the Greek word *rhein,* which means *to flow.* Rhythm fills the world with repetition and flow, from the beat of our hearts to the rise and fall of ocean tides.

Rhythm in poetry means the flow of sound produced by language. In many poems, we can sense something repeating in the rhythm. This pattern of rhythm in a poem is called *metre.* Metre gives form to what we hear in a poem by telling us what to expect the flow of language to do from line to line. However, the actual rhythm of any line may not follow the metre exactly. In certain poems, the rhythm varies so much from the metre that the sense of metre is almost lost. The poet's decision to follow the metre closely or to vary from it greatly depends on the particular effects the poet wants to create. The poet may also decide to use no metre at all. Much modern poetry has no metre.

Metre varies according to the sounds of the language in which a poem is written. For example, Cheyenne, an American Indian language, has whispered syllables as well as spoken ones. The metres of Cheyenne poetry reflect this characteristic. The ancient Greeks based their metres on the long and short vowels in their words.

In poetry written in English, metres are based on syllables and on *stress* (the vocal emphasis given to a syllable). Poets who work in English use three chief types of metres: (1) syllabic, (2) stress, and (3) foot-verse.

*Syllabic metres* are based on the number of syllables in a line. The most common syllabic metres are *continuous syllabics* and *stanzaic syllabics.*

In continuous syllabics, the poet uses the same number of syllables in each line of the poem. In stanzaic syllabics, the number of syllables in each line of the first stanza is repeated in the corresponding lines of all other stanzas. The American poet Marianne Moore used a stanzaic syllabic metre in "An Egyptian Pulled Glass Bottle in the Shape of a Fish" (1924):

Here we have thirst  
And patience, from the first,  
And art, as in a wave held up for us to see  
In its essential perpendicularity;

Not brittle but  
Intense—the spectrum, that  
Spectacular and nimble animal the fish,  
Whose scales turn aside the sun's sword with their polish.



In each stanza of this poem, the first line has 4 syllables, the second line 6 syllables, and the third and fourth lines 12 syllables each.

*Stress metres* are based on the number of stressed syllables in a line. The stress metres most used in the tradition of poetry in English are the folk metres. One widely used folk metre is *long measure,* which has a pattern of four beats per line. The American poet E. E. Cummings used long measure in "Anyone Lived in a Pretty How Town" (1940). In the following stanza from that poem, the long measure pattern of four beats per line quickly establishes itself. The underlined syllables and words indicate where beats might occur:

stars rain sun moon  
(and only the snow can begin to explain  
how children are apt to forget to remember  
with up so floating many bells down)



Another popular folk metre, known as *common measure,* alternates four-beat and three-beat lines. Common measure is used in ballads, hymns, lyric poems, and nursery rhymes. In the following example, the poem "I Heard a Fly Buzz," written in about 1862 by the American poet Emily Dickinson, is in common measure:

## Terms used in poetry

**Alexandrine** is a line of verse having 12 syllables. It is the most common metre in French poetry.

**Alliteration** occurs when two or more words begin with the same sound.

**Anacrusis** is one or more unstressed syllables at the beginning of a line that do not form part of the regular metre.

**Anapest** refers to a three-syllable foot in which the greatest stress falls on the final syllable.

**Assonance** is the repetition of vowel sounds with varying consonant sounds. The words *mine* and *night,* for example, have assonance of *i* sounds.

**Blank verse** means poetry in unrhymed iambic pentameter.

**Caesura** is a pause indicated by a comma, full stop, or other punctuation mark.

**Catalexis,** or **truncation,** is the omission of an expected unstressed syllable from the end of a line.

**Consonance** occurs when the same consonant sound is repeated.

**Couplet** is a pair of rhyming lines. *Closed couplets* complete a sentence in two lines. *Open couplets* continue the sentence from one pair of lines to another. *Heroic couplets* are in iambic pentameter.

**Dactyl** is a three-syllable foot in which the first syllable receives the strongest stress.

**Dimeter** is a line of two feet.

**Double rhyme** has two rhyming syllables, as in *dreary* and *weary* or *market* and *park it.*

**Elision** is the combining of two syllables into one, as in *ne'er* for *never.*

**Foot** is a metrical unit of two or more syllables.

**Free verse** means poetry without metre and without rhyme.

**Haiku** is a Japanese form consisting of 17 syllables arranged in three lines.

**Heptameter** is a line of seven feet.

**Hexameter** is a line of six feet.

**Iamb** is a two-syllable foot in which the second syllable has more stress than the first.

**Iambic pentameter** consists of a line of five iambs.

**Limerick** is a five-line form of humorous verse. It is written in *Poulter's Measure,* which consists of 13 beats and has a rhyme scheme of *aabba.*

**Metre** means the pattern of rhythm in a poem.

**Monometer** is a line that consists of one foot.

**Octameter** is a line of eight feet.

**Octave** is an eight-line stanza. It commonly refers to the first eight lines of an Italian sonnet.

**Onomatopoeia** is a word whose sound suggests the sound it refers to. For example, the word *buzz* suggests as well as refers to the sound made by bees.

**Pentameter** is a line of five feet.

**Quatrain** is a four-line stanza or four-line poem.

**Rhyme scheme** means the pattern of rhymes in a stanza or poem.

**Rondel** is a 13- or 14-line poem in which the first line, A, and the second line, B, are repeated near the middle and at the end. The 14-line form rhymes *ABba abAB abbaAB.*

**Sestet** is the last six lines of an Italian sonnet. It also refers to any six-line stanza or six-line poem.

**Sonnet** is a 14-line form with several possible rhyme schemes. The *Italian sonnet,* also called *Petrarchan sonnet,* usually rhymes *abbaabba cdecde* or *abbaabba cdcdcd.* The *English sonnet,* or *Shakespearean sonnet,* rhymes *abab cdcd efef gg.*

**Sonnet sequence** is a series of sonnets with a similar subject.

**Stanza** is a repeated pattern of lines, usually with a metre and a rhyme scheme.

**Tercet,** or **triplet,** is a three-line stanza or a three-line poem.

**Tetrameter** is a line of four feet.

**Trimeter** is a line of three feet.

**Triolet** is a complex eight-line French form, in which the first line, A, is repeated twice and the second line, B, once. Its rhyme scheme is *ABaAabAB.*

**Trochee** is a two-syllable foot in which the first syllable is more stressed than the second.

**Villanelle** is an elaborate 19-line French form. It repeats two rhyming lines, *A* and *A',* in an intricate pattern: *AbA' abA abA' abA abA' abAA'.*

I heard a Fly buzz—when I died—
The Stillness in the Room
Was like the Stillness in the Air—
Between the Heaves of Storm—

The Eyes around—had wrung them dry—
And Breaths were gathering firm
For that last Onset—when the King
Be witnessed—in the Room—

I willed my Keepsakes—Signed away
What portion of me be
Assignable—and then it was
There interposed a Fly—

With Blue—uncertain stumbling Buzz—
Between the light—and me—
And then the Windows failed—and then
I could not see to see—

When we read this poem, we pause at the end of each three-beat line. We pause because we tend to hear beats in pairs. The first line of the poem has two pairs of beats, and so we expect the following lines to repeat this pattern. Thus, we pause after the three-beat lines for the expected final beat in the second pair of beats. Such pauses are regarded as *musical pauses* because they are created by the metre of the poem. They differ from *caesuras,* which are pauses created by commas, full stops, and other punctuation marks.

A musical pause also differs from the felt pause that we should sense at the end of any line of poetry. When reading a poem aloud, people too often ignore the end of lines and read the poem as if it were prose. The trick in reading a poem aloud is to signal the ends of lines in some way without coming to a full stop. "I Heard a Fly Buzz" has many kinds of pauses, each of which adds to the poem's effect.

***Foot-verse metres*** involve both the number of syllables and the position of the stressed syllables. These combinations form *feet.* Poets have created many types of foot-verse metres. The most widely used is *iambic pentameter,* a line consisting of five *iambs.* An iamb is a two-syllable foot in which the second syllable receives more stress than the first syllable. For example, each of the words *indeed* and *between* forms a single iamb.

In many cases, the pattern of stresses in iambic pentameter is harder to hear than in stress metres. In a line of stress metre, we easily recognize the pattern of heavy stresses. In a line of iambic pentameter, however, we must consider all the syllables and compare the stresses of the two syllables that make up each foot.

If a poem is said to be written in iambic pentameter, the reader can expect each line of the poem to consist of five iambs. In some poems, the rhythm of the lines fulfils that expectation in a precise pattern, as it does in these final two lines from "Composed Upon Westminster Bridge, September 3, 1802" by the English poet William Wordsworth:

Dĕar Gód! | thĕ vé|rў hóus|ĕs seém | ăsleép;
Ănd áll | thăt míght|ў heárt | ĭs lý|ĭng stíll!

The syllable that has less stress in each foot is marked with a breve ( ˘ ). The syllable with greater stress is marked with an accent ( ´ ). The feet are separated by vertical lines called *foot boundaries.* Marking poetry in this way to find its metrical pattern is called *scanning.*

Most poets do not try to fit the rhythm to the metre exactly. Instead, they strive for the most appropriate kind of fit for the effect they wish to create. This technique was used by the Jamaican-born poet Claude McKay in "If We Must Die" (1922) in iambic pentameter. But the rhythm of the last two lines of the poem only roughly fits that metre:

Lĭke mén | wĕ'll fáce | thĕ múr|dĕrŏus, ców|ărdlў páck,
Préssed tŏ | thĕ wáll, | dýĭng, | bŭt fíght|ĭng báck!



In the fourth and fifth feet of the first line, McKay used a three-syllable foot instead of an iamb. In the second line, he substituted a *trochee* for an iamb in the first and third feet. A trochee is a two-syllable foot with the stress heavier on the first syllable. The rhythm of these two lines fights against the poem's metre, much as the men in the poem fight the pack.

**Sounds.** Poets often use the sounds of words to create effects in their poems. The most common method is to use words that rhyme. If the words at the ends of two or more lines of a poem rhyme, the poem has a *rhyme scheme.* The English poet Gerard Manley Hopkins used a rhyme scheme in "Pied Beauty." This poem, written in 1877, celebrates *pied,* or *dappled,* things—that is, spotted, many-coloured things:

Glory be to God for dappled things—
  For skies of couple-colour as a brinded cow;
    For rose-moles all in stipple upon trout that swim;
Fresh-firecoal chestnut-falls; finches' wings;
  Landscape plotted and pieced—fold, fallow, and plough;
    And all trades, their gear and tackle and trim.

All things counter, original, spare, strange;
  Whatever is fickle, freckled (who knows how?)
    With swift, slow; sweet, sour; adazzle, dim;
He fathers-forth whose beauty is past change:
                                        Praise him.

In the standard way of indicating a rhyme scheme, the letter *a* represents the first rhyme sound, *b* the second, *c* the third, and so on. Thus, the rhyme scheme of "Pied Beauty" is *abcabc dbcdc.*

Poets also achieve effects by using words that have similar sounds but do not rhyme. Many such words appear in "Pied Beauty." For example, the first two lines of the poem have words that begin with the same *g* sound ("*G*lory be to *G*od") and the same *c* sound ("*c*ouple-*c*olour as a brinded *c*ow"). Such repetition of the same first sounds in words is called *alliteration. Consonance* occurs when the same consonant sound is repeated. The third line of "Pied Beauty" has consonance of *l* sounds ("rose-mo*l*es a*ll* in stipp*l*e") and *t* sounds ("*t*rout tha*t* swim"). The repetition of a vowel sound is called *assonance.* In the fourth line of the poem, the *e* sounds and the last two *i* sounds are examples of assonance ("Fresh-firecoal ch*e*stnut-falls; f*i*nches' w*i*ngs"). The fifth line of "Pied Beauty" combines alliteration, consonance, and assonance. Hopkins thus created a poem that in itself is a "dappled thing" of sound.

**Imagery** refers to the sensations that language creates in the mind. These sensations, or images, are often thought of as being like pictures. But images are not limited to visual sensations. For example, the first three stanzas of "The Snow Man" (1923) by the American

poet Wallace Stevens appeal to our sense of touch and our sense of hearing:

> One must have a mind of winter
> To regard the frost and the boughs
> Of the pinetrees crusted with snow;
>
> And have been cold a long time
> To behold the junipers shagged with ice,
> The spruces rough in the distant glitter
>
> Of the January sun; and not to think
> Of any misery in the sound of the wind,
> In the sound of a few leaves. . . .



In these lines, such phrases as "crusted with snow," "shagged with ice," and "rough in the distant glitter" help us sense the texture of things. In the third stanza, "the sound of the wind" and "the sound of a few leaves" create images of things heard.

Poets also create images by comparing things that ordinarily have little in common. In "Little Exercise" (1946), the American poet Elizabeth Bishop compared an approaching storm to a restless dog. This comparison suggests images of both sound and movement:

> Think of the storm roaming the sky uneasily
> like a dog looking for a place to sleep in,
> listen to it growling.



**Forms.** The most common means of creating poetic form is rhyme. Some rhyme schemes have been used so often that they have become standard verse forms. One such form is the sonnet. The *Italian sonnet,* also called the *Petrarchan sonnet,* consists of an *octave* (eight-line stanza) followed by a *sestet* (six-line stanza). The rhyme scheme of the octave is *abbaabba*. The rhyme scheme of the sestet varies but often is *cdecde* or *cdcdcd*. The *English sonnet,* also called the *Shakespearean sonnet,* has a rhyme scheme of *abab cdcd efef gg*. Shakespeare used this form in his sonnets. His Sonnet 130, which was published in 1609, follows:

> My mistress' eyes are nothing like the sun—
> Coral is far more red than her lips' red—
> If snow be white, why then her breasts are dun—
> If hairs be wires, black wires grow on her head:
> I have seen roses damasked, red and white,
> But no such roses see I in her cheeks,
> And in some perfumes is there more delight
> Than in the breath that from my mistress reeks.
> I love to hear her speak, yet well I know
> That music hath a far more pleasing sound.
> I grant I never saw a goddess go;
> My mistress when she walks treads on the ground.
> And yet by heaven I think my love as rare
> As any she belied with false compare.

A poem's metre also may determine its form. For example, *blank verse* consists of unrhymed lines of iambic pentameter. The English poet John Milton wrote the great epic *Paradise Lost* (1667) in blank verse.

Much poetry, especially that written in the 1900's, has no rhyme scheme and no metre. Such poetry is often called *free verse.* The American poet Theodore Roethke used no rhyme scheme and no metre in "Root Cellar" (1943). The unpredictable form of Roethke's poem echoes the unexpected behaviour of the things in the cellar:

> Nothing would sleep in that cellar, dank as a ditch,
> Bulbs broke out of boxes hunting for chinks in the dark,
> Shoots dangled and drooped,
> Lolling obscenely from mildewed crates,
> Hung down long yellow evil necks, like tropical snakes.
> And what a congress of stinks!
> Roots ripe as old bait,
> Pulpy stems, rank, silo-rich,
> Leaf-mould, manure, lime, piled against slippery planks.
> Nothing would give up life:
> Even the dirt kept breathing a small breath.



## History

**Ancient poetry.** Poets have been an important part of many cultures since early times. Many of the great written poems that have come down to us were originally oral poems that performers recited at religious festivals and important public ceremonies. Western poetry developed from the ancient Greek tradition, which distinguished between epic, lyric, and dramatic poetry.

The oldest surviving Greek poems are the great epics the *Iliad* and the *Odyssey.* These works, which are attributed to Homer, were probably written during the 700's B.C. They were composed from pieces of Greek oral poetry. After Homer's time, poets recited the epics from memory before large audiences at Greek festivals.

Lyric poetry in ancient Greece was recited by one person or by a large group called a *chorus.* Sappho, a Greek woman poet of the 500's B.C., composed many elegant love lyrics. Many later poets have written poems consisting of four-line stanzas called *Sapphics,* which imitate the style of Sappho. Pindar, who lived during the

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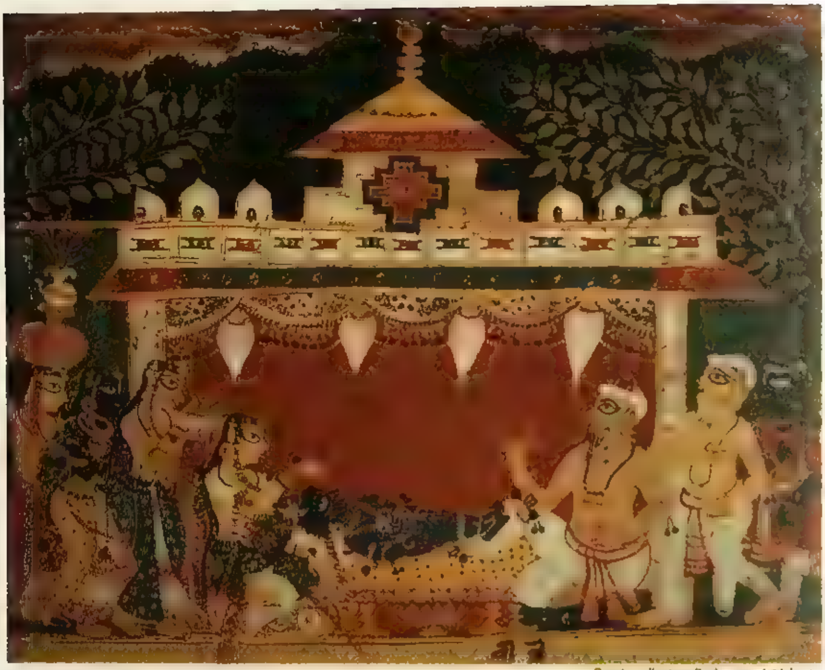
**The journey of Odysseus** after the Trojan War is described in th Greek epic poem, the *Odyssey.* Odysseus is also known by his Lat name, Ulysses.



**The *Bhagavata Purana*** dates from the A.D. 800's. In this collection, Indian poets tell the story of the Hindu god Krishna.

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400's B.C., was the greatest Greek choral lyric poet. Most scholars credit him with developing the classical ode.

Greek dramatic poets included some of the finest playwrights in history. Aeschylus, Euripides, and Sophocles, all of whom lived in the 400's B.C., composed masterpieces of tragedy. Aristophanes, another Greek poet of the 400's B.C., wrote brilliant comedies.

Greek poetry strongly influenced the poets of ancient Rome. For example, the *Iliad* and the *Odyssey* served as models for the *Aeneid,* an epic composed by the Roman poet Virgil between 30 and 19 B.C. This masterpiece tells the story of Aeneas, a mythical Trojan warrior. Other outstanding poets of ancient Rome included Ovid, Catullus, and Juvenal. Ovid and Catullus composed graceful love poems. Juvenal became famous for stinging *satires*—works that ridicule certain aspects of human behaviour.

The Old Testament contains beautiful poetry of the ancient Hebrews. Much of the Old Testament began as oral literature and was written down over hundreds of years. The Psalms and the Song of Solomon provide examples of some of the loveliest and most powerful Hebrew lyrics. Hebrew poets created rhythm in their verse by repeating words, ideas, and images.

The longest poem ever written is the Indian epic, the *Mahabharata.* This famous Sanskrit poem, dating back about 2,000 years, is about 15 times the length of the Bible and more than 100,000 stanzas long. Poets have continued to revise and reshape it over the centuries. The *Mahabharata* is still very popular today.

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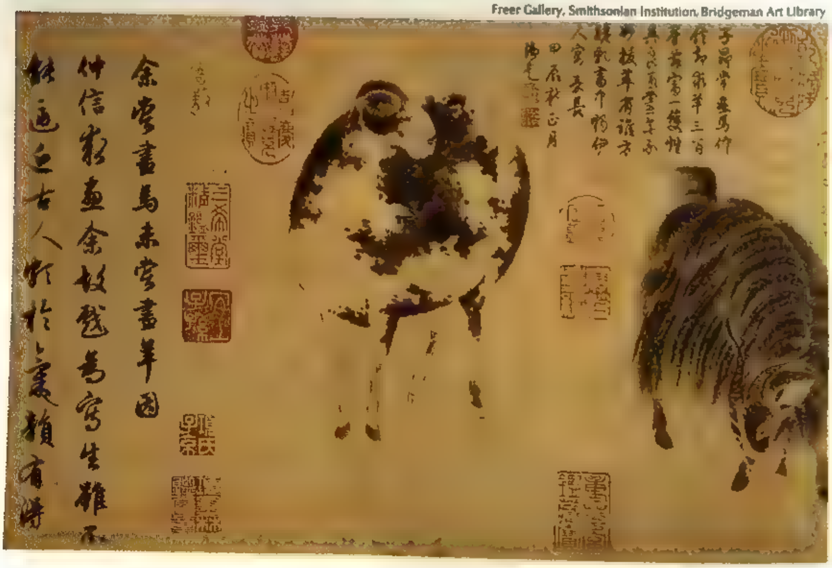

**Traditional Chinese poetry** combines *calligraphy* (beautiful handwriting) and delicate drawings, as in this work, "Sheep and goat," dating from the Yuan dynasty (1279-1368).

Lyric poetry flourished in other ancient cultures. Many of the poems of the great Chinese lyricists have enjoyed popularity for more than 2,000 years.

**Medieval poetry** was written during the Middle Ages, the period of European history following the collapse of the Roman Empire in the A.D. 400's until the 1400's. Few poems were preserved in written form before 1100. However, after studying manuscripts that remain we know that early poems were mainly epics, telling stories of rulers, chieftains, and dynasties.

The English epic *Beowulf,* one of the most famous early poems, dates from the 700's. It tells the story of the Danish hero Beowulf, who defeated bloodthirsty monsters and eventually died a heroic death. *The Song of Roland,* the French epic poem of the early 1100's, is an account of the strength in battle and the noble death of the great knight Roland, who fought against the Saracens. This poem inspired poets from many countries to write more about the hero Roland (or Orlando, as he was known in Italian).

Written epics evolved out of existing oral poetry. The German epic *The Song of the Nibelungs* dates from the 1200's, but the subject matter dates back centuries before that time. Written poems about King Arthur, a legendary Celtic hero, first appeared in the 1300's, but they began as oral poems in Welsh and other Celtic languages. Poets were known as *bards* or *skalds* and were respected as entertainers and as people who knew about history. The Irish bards were of great importance in society.

Around 900, European poetry began to follow the Arabic lyric tradition and the epic declined in popularity. Arabic lyrics were shorter, more musical poems dealing with subjects like love, the beauties of nature, the harmony of the universe, and people's relations with God. The new poetry spread from North Africa, through Muslim Spain, and into France. There, courtly poets known as *troubadours* composed and sang lyric poems. In Germany, these poets were called *minnesingers.*

The new lyric style of poetry writing shifted the emphasis of poetry from accounts of battles to stories of love. During the 1300's, the military epics declined in importance. The *romance* became the chief form of poetry. Romances told the stories of the lives and loves of heroes and heroines such as Tristan and Isolde or Lancelot and Guenevere.

Three of the greatest European medieval poets developed these different kinds of poetry in new ways. An Italian poet, Dante Alighieri, wrote *The Divine Comedy* in the early 1300's. It is a long poem about a dream journey through hell, purgatory, and on up to heaven. Dante's fellow Italian, Petrarch, invented new forms of the lyric that combined both love poetry and religious poetry. His lyrics were imitated for centuries. In England in the late 1300's, Geoffrey Chaucer wrote *The Canterbury Tales,* a collection of narrative poems about a group of pilgrims on their way to the shrine of Thomas à Becket. The pilgrims entertained each other by telling stories, some tragic and some comic.

The great Turkish poet Yunus Emre (mid 1200's to early 1300's) also wrote religious poetry. In his poems he used simple language to describe mystical experiences. His poetry laid the foundations for later developments in Turkish literature.

**The Renaissance.** During this period of great changes in European culture from about 1450 to 1650, new forms and styles of poetry began to appear. During the medieval period, writers began to use the languages that people spoke instead of Latin, which was the language of religion and of learning. By the 1400's, most European languages had rich literatures. The invention of printing in the late 1400's meant that books were more easily available and the number of people able to read increased.

The Renaissance was a period of great cultural achievements in many fields, including painting, music, architecture, and literature. Famous people like Leonardo da Vinci and Michelangelo were poets, painters, mathematicians, and sculptors; rulers like Queen Elizabeth I of England and Queen Marguerite of Navarre in France also wrote poetry and studied the classics. The Renaissance was also a period of great expeditions to new and uncharted parts of the world. These voyages of discovery inspired popular imagination and introduced Europeans to other cultures beyond the oceans. In 1527, the great Portuguese writer Luis de Camões published *The Lusiads,* his great poem about the discovery of new worlds.

In Italy, poets such as Lodovico Ariosto and Torquato Tasso created long, complex poems combining elements of epic, romance, and lyric in exciting new ways. In England, Edmund Spenser wrote a similar type of poem, *The Faerie Queen,* published in the 1590's. John Milton's *Paradise Lost,* which was published in 1667, is the last great example of this type of poem.

Dramatic poetry also flourished in England at this time. The plays of Christopher Marlowe, such as *Tamburlaine the Great* and *The Tragical History of Doctor Faustus,* appeared in the 1580's and 1590's. The greatest English writer of his age, William Shakespeare, produced his poems and verse dramas between 1590 and 1613.

Marlowe and Shakespeare developed unrhymed or *blank* verse, using a 10-syllable line. In France, the 12-syllable line, the *alexandrine,* became the basic form for dramatic poetry. In Spain, Lope de Vega wrote a huge number of poems and plays. Another popular European Renaissance form was the *pastoral,* which portrayed idealized scenes of country life.

The Renaissance was a time when new developments in the lyric spread across Europe, influenced by the medieval poet Petrarch. Poets wrote powerful personal lyrics. Some, like Sir Thomas Wyatt and Sir Philip Sidney in England; Garcilaso de la Vega in Spain; Louise Labé in France; and Gaspara Stampa in Italy, wrote principally about love. Others, like St. John of the Cross in Spain, Sor Juana Inés de la Cruz in Mexico, Vittoria Colonna in Italy, and John Donne in England, wrote about their own inner religious conflicts. Donne was one of the *metaphysical poets,* whose style was to create poems full of elaborate, often strange images. Luis de Gongora in Spain wrote similarly ornate poems. In Turkey, Bâkî wrote some of the most famous poems in the Turkish language.

**The Enlightenment.** In the late 1600's, European poets went back to ancient Greece and Rome for inspiration, and this period is often called the *neoclassical* (new-classical) age. Jean Racine in France wrote verse

dramas that followed poetic principles established by Aristotle. In England, John Dryden and Alexander Pope translated from the Greek and Latin and wrote poetry using the form of the *heroic couplet,* two rhymed lines of iambic pentameter.

The preference of the age was for order and harmony in poetry, with no violent emotions. Ironic and satirical poetry was popular, and poets used verse to criticize politicians and other leading public figures. Across the Atlantic, in New England, U.S.A., Anne Bradstreet was the first important American poet writing in English. She wrote personal poems about her life and feelings.

Regular trade links with many parts of the world led to an interest in poetry from other cultures, and in the 1700's a great deal of classical Chinese and Arabic poetry was translated into European languages. Great intellectuals like Voltaire in France and Goethe in Germany saw themselves as citizens of the world, and sought inspiration for their writings from poets of the past and present.

**Romantic poetry** began to emerge in the late 1700's in the age of revolutions. The American Revolution of 1776 and the French Revolution of 1789 changed the public's perception about the relationship between people and government. All over the world, writers began using poetry as a way of expressing their frustrations and celebrating their national identity. In many countries, writers had been forbidden to write poetry in their native language, but now that began to change. In Scotland, Robert Burns wrote lyric poems in Scots dialect. In Greece, Dionysus Solomos published his *Hymn to Liberty* in 1823.

The English poet Lord Byron was one of the most popular figures of the age. Writers all over Europe and in Spanish America imitated Byron's work. Byron saw the poet as a free spirit who has a duty both to express feelings and to speak out honestly against oppression. The Byronic hero who roams the world looking for personal salvation was a symbol of the age. Influenced by Byron, Karel Macha wrote poetry in Czech and paved the way for a flowering of Czech literature, while Sandor Petöfi wrote some of the greatest Hungarian poetry. As nations struggled for independence, the role of the poet to inspire people and remind them of their origins and their identity became significant.

Romantic poetry in English began with the publication in 1798 of *Lyrical Ballads* by William Wordsworth and Samuel Taylor Coleridge. Both these poets, like William Blake, Percy Bysshe Shelley, and John Keats, were reacting against the orderly style of the neoclassicists and wanted poetry to be a means of expressing strong emotion. Poets often wrote in the first person and wrote openly about their own lives and experiences. Alphonse de Lamartine and Victor Hugo in France; Goethe, Johann Schiller, and Heinrich Heine in Germany; Alexander Pushkin in Russia; Giacomo Leopardi and Ugo Foscolo in Italy all wrote poetry about their innermost feelings, unafraid to expose their weaknesses and doubts to their readers. Later writers such as Robert Browning, Elizabeth Barrett Browning, and Emily Dickinson were all influenced by this kind of openness and honesty.

**The Age of Materialism.** The influence of the Romantics continued through the 1800's, a time when dramatic changes in farming and in industry meant that millions of people were moving to live in big cities, often in appalling conditions. At the same time, others were pressing outward in search of new territories. In Europe and in South America, struggles for independence continued, while in the United States, Canada, Australia, and Africa, more and more land was being taken over for development by white settlers, often at the expense of the peoples who had lived there for centuries. Many European writers did not consider the literatures of other cultures as important as their own. Edward Fitzgerald, who wrote a version of the Persian mystical poem, *The Rubaiyat of Omar Khayyam,* felt that English literature was superior.

The publication of Charles Darwin's *The Origin of Species* in 1859 created a sensation, for he argued that human beings had not been created directly by God but had evolved as a species over millions of years. This view challenged religious belief in the Creation, and many people were deeply disturbed by this idea. All these changes affected poets. Writers like Edgar Allan Poe, Charles Baudelaire, and Alfred Lord Tennyson looked at the darker side of human nature in their poems.

Not all poetry of this time is pessimistic. In the United States, Henry Wadsworth Longfellow and Walt Whitman tried to create an authentic American voice in their writing. Longfellow favoured traditional forms. Whitman preferred to use everyday language and dialect, and often abandoned rhyme schemes and wrote in free verse. Whitman's collection *Leaves of Grass,* first published in 1855, has had a huge impact on writers across the Americas.

**Beginnings of modern poetry.** Toward the end of the 1800's, a movement called *symbolism* developed in France. Baudelaire's collection *Flowers of Evil* (1857) was one of the first to appear. Other symbolists include Arthur Rimbaud, Stéphane Mallarmé, and Paul Verlaine. These poets believed that the task of poetry was to create impressions in the mind of the reader, and they used sound and images in unique new combinations. The symbolists considered meaning less important than the impression produced. The symbolists had a great impact on later writers like T. S. Eliot (U.S.A.), W. B. Yeats (Ireland), Stefan George and Rainer Maria Rilke (Germany), Juan Ramón Jiménez (Spain), and Alexander Blok (Russia).

A poetic movement called *imagism* emerged in the early 1900's. The imagists were a group of English and American poets, including Ezra Pound, Wallace Stevens, and Marianne Moore. Imagist poets used a variety of rhythms to create pictures with words. Both symbolism and imagism are closely linked with developments in painting. The French impressionists painted pictures that gave a view of reality rather than reproducing reality photographically. Surrealist painters created powerful pictures that did not attempt to reproduce real images at all. Poets like Ezra Pound took their inspiration from Chinese and Japanese poetry, where the visual is important.

"The Waste Land" is the title of a poem by T. S. Eliot published in 1922. It uses a wide range of other poems as sources and combines elements from different literatures from around the world. It is a pessimistic poem and reflects the feelings of many poets writing in the

early 1900's, a period of great change. In Europe, World War I killed millions between 1914 and 1918. There were revolutions, civil wars, and extreme violence in Mexico and other parts of Latin America, in Russia, and in China. Throughout the world there was a sense of uncertainty and doubt, which writers tried to express in their poetry. Poets including Guillaume Apollinaire (France), Wilfrid Owen and Siegfried Sassoon (England), and Giuseppe Ungaretti (Italy) wrote about their experiences of the horrors of war in plain, everyday language, showing that poetry did not have to be about beautiful things but it could also be about the ugly, terrible things which are also a part of the world.

**Contemporary poetry** is as varied and as flexible as the world we live in. Poetry does not have to conform to fixed rules about rhyme or length as in previous ages, and many writers have experimented with language and invented new forms. Poetry has become more international, and readers throughout the world enjoy the poetry of writers such as Pablo Neruda (Chile), Vladimir Mayakowsky (Russia), Czeslaw Milosz (Poland), Seamus Heaney (Ireland), Octavio Paz (Mexico), Sylvia Plath (U.S.A.), and Nina Cassian (Romania). Traditional forms of poetry have survived and continue to flourish alongside new forms and many young people enjoy the poetry of pop music lyrics.

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|---|---|
| Bunin, Ivan | Pushkin, Alexander |
| Pasternak, Boris | Yevtushenko, Yevgeny |

**Scandinavian poets**

| | |
|---|---|
| Bjørnson, Bjørnstjerne | Wergeland, Henrik A. |
| Lagerkvist, Pär F. | |

**Spanish poets**

| | |
|---|---|
| Aleixandre, Vicente | Jiménez, Juan Ramón |
| García Lorca, Federico | Unamuno, Miguel de |
| Góngora, Luis de | |

**Other poets**

| | |
|---|---|
| Bialik, Chaim N. | Li Bo |
| Gibran, Kahlil | Shevchenko, Taras |
| Halevi, Judah | Tagore, Rabindranath |
| Iqbal, Sir Muhammad | |

**Famous poems**

| | | |
|---|---|---|
| Aeneid | Frietchie, Barbara | Odyssey |
| Beowulf | Gilgamesh, Epic of | Ramayana |
| Canterbury Tales | Iliad | Roland |
| Divine Comedy | Mahabharata | Rubaiyat |
| Evangeline | Nibelungenlied | Song of Hiawatha |

**Forms of poetry**

| | | | |
|---|---|---|---|
| Ballad | Epic | Free verse | Ode |
| Blank verse | Epigram | Idyll | Sonnet |
| Elegy | Epitaph | Limerick | |

**Poets and minstrels**

| | | | |
|---|---|---|---|
| Bard | Minnesinger | Poet laureate | Trouvère |
| Mastersinger | Minstrel | Troubadour | |

**Other related articles**

| | |
|---|---|
| Elision | Pre-Raphaelite Brotherhood |
| Figure of speech | Rhyme |
| Metaphysical poets | Rhythm |
| Metre (poetry) | |

**Outline**

- **I. Kinds of poetry**
  - A. Lyric poetry
  - B. Narrative poetry
  - C. Dramatic poetry
- **II. The elements of poetry**
  - A. Rhythm and metre
  - B. Sounds
  - C. Imagery
  - D. Forms
- **III. History**

**Questions**

What are the three main kinds of poetry?
In which country did the *alexandrine* become the basic form for dramatic poetry during the Renaissance?
What is the difference between rhythm and metre?
What are the three parts of the *classical ode?*
*What is a dramatic monologue?*
What are the chief types of metre used for poetry in English?
How do epics differ from ballads?
What is *alliteration? Consonance? Assonance?*
Who were the *imagists?*
What is *blank verse? Free verse?*

**Poets' Corner.** See **Westminster Abbey.**

**Pogrom.** See **Genocide; Jews** (The growth of anti-Semitism).

**Pohnpei** is the largest island of the eastern Caroline Islands. Pohnpei (also spelled Ponape) lies in the western Pacific Ocean, 1,207 kilometres southeast of Guam. For location, see **Pacific Islands** (map). The island, which is volcanic rock surrounded by coral reefs, has an area of 334 square kilometres. About 20,000 people live on Pohnpei.

The shores of Pohnpei are mangrove swamps. Firm ground with rich vegetation lies inland. Mountains rise over 700 metres. Pohnpei is famous for its fine yams. Other crops include coconuts, taros, bananas, breadfruit, and limes. The climate is moist and hot, with heavy rainfall between June and September.

Germany bought Pohnpei from Spain in 1899. Japan, an enemy of Germany during World War I, occupied Pohnpei in 1914. The Treaty of Versailles gave it to Japan in 1920. During World War II (1939-1945), Japan used the island as an air base. After the war, Japan surrendered it to the Allies.

The United States took control of Pohnpei as part of a United Nations trusteeship in 1947. In 1980, Pohnpei and other Caroline Islands formed the Federated States of Micronesia. In 1986, these islands became a self-governing political unit in free association with the United States.

**Poi.** See **Hawaii** (Food).

**Poincaré, (Jules)-Henri** (1854-1912), a French mathematician and philosopher of science, solved a variety of problems in mathematics and physics. He was born in Nancy and obtained a doctorate from the École Nationale Supérieure des Mines, in Paris, in 1879.

In 1880, Poincaré became an instructor at the University of Caen. The following year, he became a science lecturer at the University of Paris. Poincaré lectured on a wide variety of subjects, including applied mathematics, astronomy, celestial mechanics, physics, probability theory, and topology. Later in his life, he turned to the philosophy of science and wrote a series of influential popular books in this field.

**Henri Poincaré**

**Poincaré, Raymond** (1860-1934), served four times as premier of France, and was president of France from 1913 to 1920. He gained a reputation as a financier and an ardent nationalist.

Poincaré first became premier in 1912 and tried to strengthen French alliances. In 1922, after his term as president, he became premier again. The Treaty of Versailles, which officially ended World War I (1914-1918), required Germany to pay *reparations* (compensation for war damages) to France. In 1923, after the Reparations Commission declared Germany in default, Poincaré ordered French troops into the Ruhr to force Germany to pay (see **Ruhr** [History]). Poincaré was defeated in the 1924 elections and resigned his premiership.

Poinciana is a tree native to Madagascar. It has attractive clusters of brightly coloured flowers.

He served as premier again from 1926 to 1928, during a financial and political crisis. His measures to stabilize the French economy won him the title "saviour of the franc." After a fourth premiership from 1928 to 1929, he resigned. Poincaré was born on Aug. 20, 1860, in Bar-le-Duc, France.

**Poinciana,** also known as the flamboyant tree, is one of the finest of all tropical flowering trees. It is a native of Madagascar, but has been widely planted in warm climates because of its immense clusters of brilliant flowers. Each flower is from 8 to 10 centimetres across, with 5 widely spreading red petals. One of these petals is streaked and dotted with yellow. There are 10 long stamens that stand well above the flower. The blossoms are followed by purplish-brown seed pods, which are at least 60 centimetres long. The pods contain hard, oblong beans. In some countries, people burn the pods as fuel.

Poincianas are commonly planted along roadsides. In a brief flowering season, they turn the roads along which they grow into lines of fiery red. The trees have lacy, fernlike leaves, divided into many tiny leaflets. The trees grow rapidly, soon developing strong, gnarled trunks and spreading branches. They may reach a height of 30 metres.

**Scientific classification.** Poincianas are in the pea family, Leguminosae (Fabaceae). They make up the genus *Poinciana*. The flamboyant tree is *Delonix regia*.

**Poinsettia** is a plant that has tiny flowers surrounded by large, coloured *bracts* (special leaves). The bracts are usually bright red, but may also be yellowish or white. The brilliant red bracts contrast with the green leaves and make the poinsettia popular for decoration during the Christmas season. In tropical and subtropical regions, the poinsettia thrives outdoors. It may grow 0.6 to 4.6 metres tall. The poinsettia is native to Mexico. It is a popular garden shrub in many countries In cold climates, it must be grown indoors. As a pot plant, it grows from 30 to 120 centimetres tall. The leaves and stem can cause abdominal cramps if eaten. The plant's sap can irritate the skin and eyes.

**Scientific classification.** The poinsettia belongs to the spurge family, Euphorbiaceae. It is *Euphorbia pulcherrima*.

See also **Flower** (picture: Poinsettias); **Leaf** (picture: Bright red bracts).

**Pointer** is a dog used to hunt pheasants and other game birds. The dog is called a *pointer* because it stops as still as a statue when it smells a bird, and *points* by facing in the direction of the bird, often with one front paw lifted and its tail held out stiffly behind. The pointer is classed as a gun dog and as a field dog, along with setters, spaniels, and retrievers. Setters, spaniels, and retrievers usually have long hair, but the pointer has a short, smooth coat. The pointer stands from about 60 to 70 centimetres high at the shoulder and weighs from 20 to 35 kilograms. Its coat is white with patches of lemon, *liver* (reddish-brown), black, or orange. The pointer has speed and a keen sense of smell. It is popular for hunting and field trials. See also **Dog** (picture: Sporting dogs).

**Pointillism.** See **Seurat, Georges; Painting** (Post-impressionism).

**Pointing the bone** is a magic ritual used by Australian Aborigines with the intention of injuring or killing their enemies. The man who performs the ritual points or jerks a bone or stick at his enemy and chants a prescribed song. The Aborigine stands in a special position and exercises extreme care while performing the ritual, believing that, if he should make a mistake, he and not his intended victim may die. Aborigines believe firmly in the magic power of the ritual. The person at whom the bone is pointed may even die as a result of suggestion.

**Poison** is any substance that kills living things or makes them ill. Poisons may be swallowed, inhaled, injected, or absorbed by the skin or body membranes. The study of poisons is called *toxicology*, and many poisons are called *toxins*.

The most potent poisons are usually kept only in laboratories. They cause few deaths because they are seldom found in everyday surroundings. Most deaths are caused by weaker poisons that are contained in common household products. Many poisonings occur when people fail to pay attention to labels and instructions on containers of chemical substances. Household products that can cause poisonings and deaths include insect sprays, rat poisons, cleaning and polishing compounds, and such fuels as petrol. Even detergents have caused fatal poisonings when swallowed. Medications taken in large amounts can also cause poisoning.

To avoid being poisoned, never eat untested foods, such as wild mushrooms or berries, or foods in unlabelled containers. Keep all medicines and chemicals out of the reach of small children. Children are more sensitive to poison than adults, and a smaller amount may cause a child's death. Also, young children may swallow a large amount of a bad-tasting chemical that an adult would avoid, such as bleach.

Poison control centres have been set up in the UK, U.S.A., and some other countries to give emergency information to doctors and the public. They furnish first aid information and the location of the nearest hospital. Some centres advise only doctors on the appropriate *antidote*. An antidote is a substance that relieves the harmful effects of poisons.

Poisons can be useful and can even be used to save lives. Useful medicines, such as *curare* and *ouabain*, were discovered because they were used first as poisons on the heads of arrows. Ouabain is similar to the drug *digitalis* (see **Digitalis**).

**Plant and animal poisoning.** When organisms, such as certain bacteria, produce a poison, the poison is called a *toxin* (see **Toxin**). Some fungi produce toxins that are dangerous to human beings when swallowed in infested food. For example, some mushrooms have a toxic effect when eaten.

Many plants, such as deadly nightshade and laburnum, produce poisons that can be dangerous for human beings and livestock. Plant roots, stems, leaves, seeds, and fruits may contain poison.

Many animals have poisonous bites or stings. These include bees, wasps, scorpions, snakes, spiders, octopuses, and snails. Most animals use their poison to defend themselves or to hunt prey. Some fish, such as stingrays, have poisonous spines. Some salamanders, frogs, and toads have poison in their skin. For more information, see the *World Book* articles on **Snakebite** and each of the above animals.

**Kinds of poisons.** Scientists classify poisons in many different ways. A common classification lists five kinds: (1) corrosive poisons, (2) irritant poisons, (3) systemic poisons, (4) poisonous gases, and (5) poisonous foods.

Corrosive poisons destroy living tissue that they touch. Hydrochloric acid, nitric acid, and sodium hydroxide are corrosive poisons. A person who swallows this type of poison may destroy the lining of his or her mouth and throat.

Irritant poisons cause *inflammation* (swelling and soreness) of the mucous membranes. These membranes line many air passages of the body, such as the nose. Irritants also affect the stomach, intestines, and nerve centres. Arsenic, lead, and most of the metallic poisons are irritant poisons. Arsenic causes vomiting and may affect the heart, kidneys, and other organs.

Systemic poisons attack the nervous system and other important organs of the body, such as the kidneys, liver, and heart. Strychnine, a common rat poison, causes convulsions and difficulty in swallowing (see **Strychnine**). Hydrocyanic acid and overdoses of heroin and cocaine may cause death. The deadly nightshade plant's poisonous berries produce hot flushes, thirst, and *delirium* (disorder of the mind) if they are eaten. Many *barbiturates* (sedatives) are systemic poisons when taken in large doses.

Poisonous gases make breathing difficult and can cause death. Some poisonous gases, such as carbon monoxide from motor vehicle exhausts and gas heaters, are especially dangerous because they are difficult to notice at first. A number of poisonous gases irritate the lungs, eyes, nose, or skin.

Food poisoning can come from eating certain chemicals or organisms and their toxins. Chemicals, such as insecticides, and plants and animals, such as hemlock, Japanese pufferfish, and certain shellfish, can cause food poisoning.

*Botulism,* poisoning caused by a toxin produced by bacteria, can cause paralysis and death.

**Treatment for poisoning**

For emergency treatment for poisoning, call your hospital or doctor immediately. If possible, tell the doctor the name of the poison. These emergency steps may be taken if no other advice has been given:

**Swallowed poison.** If the poison is a corrosive poison, such as sodium hydroxide or rust remover, or a petroleum product, such as petrol, DO NOT make the patient vomit. If the patient can swallow and is conscious, give the patient water and milk and wait for the doctor. If the poison is not a corrosive or petroleum product, try to make the patient vomit by touching the back of his or her throat with the blunt end of a spoon or your finger. When vomiting begins, place the patient face down with his or her head lower than the hips. Save the poison container and the patient's urine and vomit for the doctor to analyse.

**Inhaled poison.** Carry the patient to fresh air. Do not let the patient walk. Loosen all the patient's tight clothing and wrap the patient in a blanket to prevent chills. Apply artificial respiration if breathing stops or becomes irregular. Do not give alcohol in any form.

**Poison in the eye.** Hold eyes open and keep washing them with running water until the doctor arrives. Do not apply any chemicals.

**Poison on the skin and chemical burns.** Remove the patient's clothing if necessary. Drench and wash the patient's skin with water. When the poison is removed, cover the patient with loose, clean cloth. Do not use ointments or other first aid treatment for burns.

**Related articles** in *World Book* include:

| | | |
|---|---|---|
| Alkaloid | Curare | Lead poisoning |
| Antidote | Deadly nightshade | Mycotoxin |
| Arsenic | First aid | Poisonous plant |
| Asphyxiation | Food poisoning | Toxin |
| Barbiturate | Intoxication | Venom |
| Botulism | | |

**Poison gas.** See **Chemical-biological-radiological warfare; Gas mask; Fumigation.**

**Poison ivy** is a kind of harmful vine or shrub in the cashew family. It grows plentifully in parts of the United States and southern Canada. Poison ivy usually grows as a vine twining on tree trunks or straggling over the ground. But the plant often forms upright bushes if it has no support to climb upon. Species related to poison ivy include *poison oak,* which grows in the Pacific Northwest of the United States and nearby regions of Canada, and *poison sumach,* which grows in the Eastern United States. Poison oak and poison sumach both are shrubs.

The tissues of all these plants contain a poisonous oil somewhat like carbolic acid. This oil is extremely irritating if it touches the skin. It may be brushed onto the clothing or skins of people coming into contact with the plants.

**Appearance.** The leaves of poison ivy are red in early spring. Later in spring, they change to a shiny green colour. The leaves turn red or orange in autumn. Each poison ivy leaf is made up of three leaflets more or less notched at the edges. Two of the leaflets form a pair on opposite sides of the leafstalk, while the third stands by itself at the tip of the leafstalk. Small greenish flowers grow in bunches attached to the main stem close to where each leaf joins it. Later in the season, clusters of poisonous, berrylike drupes form. They are whitish, with a waxy look.

**Control and treatment.** Efforts have been made to destroy these plants by uprooting them or by spraying them with chemicals. But poison ivy and poison oak are so common that such methods have not been very effective in eliminating them.

Scientists have developed a vaccine that can be injected or swallowed. But this is effective only if taken before exposure.

**Poison ivy** has leaves that consist of three leaflets. They contain a poisonous oil that irritates the skin. The plant's white, berrylike fruit also is poisonous.

**Scientific classification.** Poison ivy, poison oak, and poison sumach belong to the cashew family, Anacardiaceae. Poison ivy is classified as *Rhus radicans* or *Toxicondendron radicans.* Poison oak is *R. diversiloba* or *T. diversilobum* and poison sumach is *R. vernix* or *T. vernix.*

See also **Poison oak; Sumach; Virginia creeper; Plant** (picture: Poisonous plants).

**Poison oak** is a type of plant related to poison ivy and poison sumach. It grows as a bush or vine. Like poison ivy, poison oak has leaves that consist of three leaflets. But each leaflet has several lobes and resembles the leaf of the white oak tree. Poison ivy leaflets do not have any lobes.

Two species of poison oak grow in North America. *Eastern poison oak* is found from the southern part of New Jersey to Florida and west to Texas and Oklahoma. *Western poison oak* grows from the Peninsula of Lower California in Mexico to British Columbia in Canada.

**Scientific classification.** Poison oak belongs to the cashew family, Anacardiaceae. Eastern poison oak is *Rhus Toxicodendron.* It is *Rhus diversiloba* or *Toxicondendron diversilobum.*

**Poison sumach.** See **Sumach.**

**Poisonous plant** is any plant that is injurious to human beings or to animals. There are many kinds of poisonous plants. Some kinds are merely unwholesome, or are only moderately poisonous. Others contain substances that are among the deadliest poisons.

Many poisonous plants look, smell, or taste disagreeable, and so people and animals avoid them. But even familiar food plants may have poisonous parts. For example, the leaves of potato and rhubarb plants are poisonous, as are the stones of apricots, cherries, and peaches. In Europe, laburnum seeds are a common cause of poisoning in children. People should never eat or even chew any part of a plant that they do not know is harmless. In case of possible poisoning, a doctor should be consulted immediately.

The deadliest plant poison occurs in the seeds of the rosary pea of the tropics. Craftworkers in many parts of the world use these pretty red-and-black seeds in making bracelets, necklaces, and rosaries. A person can be killed by eating one rosary pea seed. Another powerful poison occurs in the oleander plant. Some people have died from eating meat roasted on an oleander stick. Many have been killed by eating poisonous mushrooms, which cannot easily be distinguished from edible species. Poisonous plants have also killed many farm animals.

**Some poisonous plants**

| Name | Poisonous parts |
|---|---|
| **Aconite (Monkshood)** | Flowers, leaves, roots |
| **Azalea** | Entire plant |
| **Castor bean (Castor-oil plant)** | Seeds |
| **Chinaberry** | Berries |
| **Daphne** | Bark, berries |
| **Deadly nightshade** | Entire plant, especially berries |
| **Death camas** | Bulbs |
| **Foxglove** | Entire plant |
| **Gelsemium (Jessamine)** | Entire plant |
| **Hyacinth** | Bulbs |
| **Mistletoe** | Berries |
| **Mountain laurel** | Entire plant |
| **Mushrooms, poisonous** | Entire plant |
| **Narcissus** | Bulbs |
| **Nightshade** | Entire plant, especially unripe berries |
| **Oleander** | Entire plant |
| **Poison hemlock** | Leaves, roots, seeds |
| **Potato** | Green parts, spoiled tubers |
| **Rhododendron** | Entire plant |
| **Rhubarb** | Leaves |
| **Thorn apple (Datura)** | Entire plant |
| **Tobacco** | Leaves |
| **Water hemlock (Cowbane, Snakeroot)** | Roots young leaves |
| **Yew** | Bark, needles, seeds |

Not all poisonous plants do their harm by being eaten. Some, such as poison ivy and manchineel, irritate the skin or eyes. Certain others, known as *allergens,* are harmful only to people who are sensitive, or allergic, to them. The pollen of some plants causes hay fever and asthma. See **Allergy.**

Some families of flowering plants contain many very poisonous species. For example, the spurge family, Euphorbiaceae, includes the cassava, croton, and the castor-oil plant, all poisonous. The nightshade family, Solanaceae, includes such wholesome vegetables as the potato, tomato, and aubergine. But it also contains such deadly members as deadly nightshade, henbane, thorn apple, and several other kinds of nightshades. Several exceedingly poisonous plants, including aconite, larkspur, and hellebore, belong to the buttercup family, Ranunculaceae.

People make use of many kinds of poisonous plants. Some are lovely garden flowers. Others are used in making insecticides. Many of the most valuable drugs used in medicine are poisons extracted from plants and given in controlled doses for specific conditions. They include aconite, atropine, cocaine, digitalis, hyoscine, morphine, quinine, and strychnine.

**Related articles** in *World Book* include:

| | | | |
|---|---|---|---|
| Aconite | Hellebore | Manchineel | Poison ivy |
| Alkaloid | Hemlock | Mistletoe | Poison oak |
| Cassava | Henbane | Mountain laurel | Pokeweed |
| Castor oil | Jack-in-the-pulpit | Mushroom | Ragweed |
| Deadly nightshade | Larkspur | Nicotine | Rhubarb |
| Digitalis | Locoweed | Oleander | Sumach |
| Gelsemium | Locust | | Thorn apple |

**Poitier, Sidney** (1927- ), is an American film actor who became a symbol of the breakthrough of black per-

formers in U.S. films. He has appeared in a number of films that deal realistically with racial problems in the United States. These films include *No Way Out* (1950), *The Blackboard Jungle* (1955), *Edge of the City* (1957), *Guess Who's Coming to Dinner* (1967), and *In the Heat of the Night* (1967). Poitier won an Academy Award for his performance in *Lilies of the Field* (1963).

**Sidney Poitier**

Poitier was born in Miami, Florida, U.S.A., and grew up in the Bahamas. About 1945, he began taking acting lessons at the American Negro Theater in New York City. He appeared on the Broadway stage in *Anna Lucasta* (1948) and *A Raisin in the Sun* (1959). In 1969, he helped found the First Artists Production Company. Poitier's other films include *Cry, the Beloved Country* (1952), *Porgy and Bess* (1959), *For Love of Ivy* (1968), and *Shoot to Kill* (1988). He directed and starred in *Uptown Saturday Night* (1974). Poitier also wrote an autobiography, *This Life* (1980).

**Poitiers, Battle of,** is the name of three events. The most important battle was fought in 1356, near the present French town of Poitiers. A famous English victory in the Hundred Years' War resulted from the Battle of Poitiers. The English forces were led by Edward, "the Black Prince" of England. King John II of France led the French troops.

The English were greatly outnumbered, but the Black Prince fought skilfully. At the height of the battle the English horsemen suddenly appeared behind the French lines. The French fled, leaving King John II and his son Philip to be captured.

Two other famous battles took place at or near Poitiers. In 507, a Frankish king named Clovis defeated the Visigoths there. In 732, Charles Martel, another Frankish king, turned back Muslim invaders in fighting that began near Tours and ended near Poitiers. The 732 conflict, called the Battle of Poitiers or Battle of Tours, stopped the spread of Islam to Europe.

*The Battle of Poitiers, 25th October 732, won by Charles Martel* (1837) by Charles Auguste Steuben; Chateau de Versailles, France

**Poitiers** has been the site of three famous battles. The painting above shows the 732 conflict between the Frankish king, Charles Martel, and Muslim invaders.

See also **Edward** (The Black Prince).

**Poker** is a card game in which players make bets on the cards they hold or hope to hold. There are two basic types of poker, *draw* and *stud*. In draw poker, each player is dealt five cards. Players may then discard unwanted cards and *draw* (receive) the equivalent number of new cards. Players take turns to bet both before and after the draw.

There are several forms of stud poker. In five-card stud, players are dealt one card face down and one card face up. Then players are dealt three additional cards face up. Bets are placed after each round of cards is dealt. Seven-card stud games follow the same general rules as five-card stud except that players are each dealt seven cards. They start with two cards face down and one card up. The next three are dealt face up, and the last one face down. The best five-card hand out of the seven wins.

The following is the ranking of cards, from highest to lowest, for poker games in which the high hand wins:

Royal flush: A-K-Q-J-10 (all of one suit)

Straight flush: 2-3-4-5-6 (any five cards in sequence, all of one suit)

Four of a kind: 9-9-9-9-J (any four cards of the same value)

Full house: 8-8-8-J-J (any three of a kind plus a pair)

Flush: 4-7-9-J-K (any five cards of the same suit)

Straight: 7-8-9-10-J (any five cards in sequence from any suit)

Three of a kind: 6-6-6-4-Q (any three cards of the same value)

Two pairs: 7-7-10-10-5

One pair: J-J-7-9-A

Highest card: A-Q-9-8-4 beats A-Q-8-7-5

If two hands are of the same rank, the hand with the higher cards wins.

**Pokeweed** is a tall, branching perennial herb with greenish-white flowers and a red stem. It is native to eastern North America, and has been introduced into western North America and into other continents. Pokeweed grows to between 1 and 3 metres high. In autumn, the berries ripen to a deep purple-black. The stems, leaves, seeds, and large fleshy roots of the pokeweed are poisonous. The plants must be cut off below ground level to kill them. The leafy sprouts are edible if they are cooked properly. The berries may be used as ink and food colouring. The roots and berries have been used to treat inflammation and skin diseases. Pokeweed is also a source of several chemical compounds used in cancer research.

**Scientific classification.** Pokeweed is in the pokeweed family, Phytolaccaceae. It is *Phytolacca americana.*

**Pokeweed berries**


**Poland** is a land of beautiful countryside and rapidly growing cities. Rolling hills and rugged mountains rise in southern Poland, *left.* Since the mid-1900's, the development of various industries has resulted in many Poles moving to towns and cities, such as Warsaw, *right.* Today, about three-fifths of Poland's people live in urban areas.

# Poland

**Poland** is a large central European nation that borders on the Baltic Sea. Warsaw is Poland's capital and largest city.

Poland is named after the Polane, a Slavic tribe that lived more than a thousand years ago in what is now Poland. The name *Polane* comes from a Slavic word that means *plain* or *field.* Flat plains and gently rolling hills cover most of the country. Rugged mountains form part of the southern boundary of Poland, and thousands of small, scenic lakes dot the northern regions of the country.

The people of Poland have a rich heritage that includes many folk traditions and a strong loyalty to the Roman Catholic Church. But the 1900's have brought many changes to Poland, and some old customs have disappeared from everyday life. Before World War II (1939-1945), Poland was largely agricultural, and nearly three-quarters of its people lived in rural areas. Today, agriculture remains an important economic activity. But Poland has also developed into a major industrial nation, and about two-thirds of the population live in cities and towns.

Poland has had a long and varied history. At one time, the people of Poland ruled an empire that stretched across most of central Europe. However, foreign powers conquered and divided Poland and brought an end to its existence as a separate nation. After more than a hundred years of foreign rule, Poland became an independent republic in 1918.

Poland became a Communist country during the mid-1940's. Its Communist Party controlled the Polish government and placed many restrictions on the freedom of the Polish people. The economy performed poorly. Protests by the people led to major changes in 1989. Elections were held, and non-Communists gained great strength in the government. Restrictions on the freedom of the Polish people were lifted.

### Facts in brief about Poland

**Capital:** Warsaw.

**Official language:** Polish.

**Official name:** Rzeczypospolita Polska (Republic of Poland).

**Area:** 323,250 km². *Greatest distances*— east-west, 692 km; north-south, 636 km. *Coastline*—446 km.

**Elevation:** *Highest*—Rysy peak, 2,499 m above sea level. *Lowest*—sea level.

**Population:** *Estimated 1996 population*—38,891,000; density, 120 people per km²; distribution, 64 per cent urban, 36 per cent rural. *1988 census*—37,878,641. *Estimated 2001 population*—41,444,000.

**Chief products:** *Agriculture*—barley, pigs, potatoes, rye, sugar beet, wheat. *Manufacturing*—chemicals, food products, iron and steel, machinery, ships, textiles. *Mining*—coal, copper, silver, sulphur.

**National anthem:** "Jeszcze Polska nie Zginęła" ("Poland Has Not Yet Perished").

**Money:** *Currency unit*—zloty. One zloty=100 groszy.

## Government

The 1952 Constitution of Poland established the country as a *people's republic.* In theory, the working people of Poland held all political power. But the Communist Party actually controlled the government until a coalition government was formed in 1989.

In addition to the Communist Party, the country allowed only a few other small parties, and they supported the Communist Party policies. But in 1989, Poland held its freest parliamentary elections since the Communists took control of the government. Non-Communist groups were allowed to organize and endorse candidates for the elections. Solidarity, a non-Communist organization of free trade unions, received overwhelming support in the elections. Candidates it endorsed were allowed to run for 35 per cent of the seats in the lower house of parliament and all the seats in the upper house. The remaining 65 per cent of the lower house seats were reserved for members of the Communist Party and its allies. Solidarity candidates won all the lower house seats that they contested, and all but one of the upper house seats. Solidarity leaders then formed a coalition government with the Communist Party and two smaller parties, and began to end Communist control.

In 1990, the Communist Party dissolved itself. New parliamentary elections were held in October 1991. This time, all seats in Parliament were contested and none were reserved for members of any specific party. The Democratic Union Party, which was formed out of a branch of Solidarity, won the most seats in both the lower house and the Senate.

Parliamentary elections were held again in September 1993. The Democratic Left Alliance and the Polish Peasant Party won the most seats. The two parties established a coalition government. The Democratic Left Alliance consists of a number of organizations, including the Social Democratic Party, which was formed by former Communist Party members. The Polish Peasant Party also includes former Communists.

**National government.** The parliament, called the National Assembly, has two houses. The lower house, or *Sejm,* has 460 members. The upper house, or *Senate,* has 100 members. The Assembly's duties include passing laws, supervising all the other branches of the government, and electing the president.

The president is Poland's head of state. The president's executive powers include the ability to declare a state of emergency, to veto legislation (which may be overturned by the Sejm), and to dissolve the National Assembly. The Sejm appoints a Council of Ministers, which carries out the operations of the government. The council includes a prime minister and other ministers. The prime minister is the head of government. The other ministers head government departments.

**Local government.** Poland is divided into 49 *voivodships* (provinces). The provinces are divided into urban and rural communities. Each province and community elects a legislative body called a *Council.* The Council elects a major or an executive council to serve as the executive body.

**Courts.** The Supreme Court is the highest court of Poland. The Council of State appoints Supreme Court judges to five-year terms. The judicial system also includes province and county courts.

**Armed forces.** About 400,000 men serve in Poland's army, navy, and air force. Men may be conscripted at age 19.

## People

**Population and ancestry.** For Poland's total population, see the *Facts in brief* table with this article. More than 98 per cent of Poland's people are Poles. They are descended from Slavic tribes that settled on the Vistula and Warta rivers several thousand years ago. Polish is related to Czech and other Slavic languages.

Minority groups make up about 4 per cent of Poland's population. The largest groups include, in order of size, Germans, Ukrainians, and Belarusians.

After World War II ended in 1945, many Poles began moving from rural areas to cities and towns. Today, about 61 per cent of the people live in urban areas, compared with only about 35 per cent in 1950.

**Way of life** in Poland has changed in many ways during the 1900's. Before World War II, Poland was largely agricultural. After the war, Poland developed into an industrial nation. Many people moved from the country's rural areas and took jobs in the cities.

**The state flag of Poland,** *left,* is flown by the government. The Polish coat of arms, *right,* appears on the state flag. The national flag, flown by the people, omits the coat of arms. An eagle has been used on the Polish coat of arms since the 1200's.


**Poland** is a country in central Europe. Its central location has contributed to many boundary changes throughout its history.

**Weddings and other family gatherings** play an important role in the social life of Poles, especially those who live in rural areas. At the country wedding shown above, the bride's attendants are dressed in traditional Polish folk costumes.

In the cities, most Polish families live in simple two- or three-room apartments. Small brick or wooden cottages provide housing in rural areas.

Bread, pork, sausages, potatoes, apples, and dairy products are favourite Polish foods. The Polish people enjoy meaty stews, hearty beetroot or cabbage soup, and mushrooms. Rich pastries and fish are eaten, especially on holidays.

Many old traditions have disappeared from everyday life in Poland. For example, folk costumes are worn only for special occasions or festivals. Most Poles, especially young people and city dwellers, prefer Western styles of dress.

But some traditions remain important. Religion, in particular, has had a strong influence on Polish life for more than a thousand years. For many Poles, social life centres around the church and family gatherings. Religious holidays, especially Christmas and Easter, are observed with festive celebrations.

Camping and hiking are some of the popular recreational activities in Poland. Poles also enjoy soccer and other sports.

**Religion.** The Poles adopted Christianity in A.D. 966. Throughout their history, they remained loyal to the Roman Catholic Church, though people in neighbouring countries practised Protestant or Eastern Orthodox religions. During the 1800's, when Poland did not exist as a separate nation, loyalty to the Roman Catholic Church helped hold the Polish people together.

In the late 1940's and early 1950's, Poland's Communist leaders tried to destroy the influence of the Roman Catholic Church in Poland. Religious practices were restricted, and many priests were imprisoned. Polish Catholics resisted these efforts, however, and after antigovernment riots in 1956, the government discontinued most of its policies against the church. Today, Poles have complete freedom of religion.

A large majority of all Poles are Roman Catholics. There are about 15,000 Roman Catholic churches in Poland and about 18,000 religious instruction centres. The Roman Catholic Church also operates the Academy of Catholic Theology in Warsaw and the Catholic University of Lublin. In 1978, Karol Cardinal Wojtyla, a Polish cardinal, became pope of the Roman Catholic Church. The first Polish pope in history, he took the name of John Paul II. Religious minority groups in Poland make up only about 5 per cent of the population. They include Protestants, Jews, and members of various Eastern Orthodox Churches.

**Education.** Poles have a long tradition of respect for education. Polish scholars, such as the astronomer Nicolaus Copernicus, have made important contributions in many fields. The first Polish university, the University of Kraków (now Jagiellonian University), was founded in 1364. Poland established a government ministry of education as early as 1773. Until the 1900's, however, education was reserved for only a small, privileged section of the population.

Today, about 98 per cent of all Poles 15 years of age or older can read and write. Most students attend free, government-operated schools. But an increasing number of students are enrolling in private schools. The law requires that children from age 7 to 15 attend school.

**Poles relax at a pavement cafe** in the main square of Kraków, a city that has long served as a centre of Polish cultural life. The towers of the Church of St. Mary rise in the background.


# Poland map index

## Provinces*

| | | | |
|---|---|---|---|
| Biała Podlaska | 306,200 | C | 6 |
| Białystok | 695,200 | B | 6 |
| Bielsko | 906,700 | F | 4 |
| Bydgoszcz | 1,116,000 | B | 3 |
| Chełm | 248,100 | D | 7 |
| Ciechanów | 429,800 | C | 5 |
| Częstochowa | 777,000 | E | 4 |
| Elbląg | 481,000 | A | 4 |
| Gdańsk | 1,438,900 | A | 4 |
| Gorzów | 502,800 | C | 2 |
| Jelenia Góra | 518,600 | D | 2 |
| Kalisz | 713,500 | D | 3 |
| Katowice | 4,006,600 | E | 4 |
| Kielce | 1,127,300 | D | 5 |
| Konin | 470,700 | C | 3 |
| Koszalin | 511,100 | A | 2 |
| Kraków | 1,234,500 | E | 4 |
| Krosno | 497,900 | F | 6 |
| Legnica | 518,500 | D | 2 |
| Leszno | 348,200 | D | 2 |
| Łódź | 1,136,600 | D | 4 |
| Łomża | 389,400 | B | 6 |
| Lublin | 1,019,600 | D | 6 |
| Nowy Sącz | 703,300 | F | 5 |
| Olsztyn | 757,200 | B | 5 |
| Opole | 1,021,200 | E | 3 |
| Ostrołęka | 398,800 | B | 5 |
| Piła | 483,500 | B | 3 |
| Piotrków | 643,000 | D | 4 |
| Płock | 517,800 | C | 4 |
| Poznań | 1,339,400 | C | 3 |
| Przemyśl | 408,300 | F | 6 |
| Radom | 753,200 | D | 5 |
| Rzeszów | 728,800 | E | 6 |
| Siedlce | 653,600 | C | 6 |
| Sieradz | 408,600 | D | 4 |
| Skierniewice | 420,700 | C | 5 |
| Słupsk | 416,800 | A | 3 |
| Suwałki | 474,100 | A | 6 |
| Szczecin | 975,900 | B | 1 |
| Tarnobrzeg | 601,700 | E | 5 |
| Tarnów | 674,600 | E | 5 |
| Toruń | 660,600 | B | 4 |
| Wałbrzych | 740,500 | E | 2 |
| Warszawa | 2,419,600 | C | 5 |
| Włocławek | 430,100 | C | 4 |
| Wrocław | 1,130,700 | D | 3 |
| Zamość | 490,500 | E | 6 |
| Zielona Góra | 662,500 | C | 2 |

## Cities and towns

| | | | |
|---|---|---|---|
| Aleksandrów Łódzki* | 20,100 | C | 4 |
| Andrychów* | 23,000 | F | 4 |
| Augustów | 28,900 | B | 6 |
| Bartoszyce | 25,700 | A | 5 |
| Będzin* | 75,800 | E | 4 |
| Bełchatów* | 59,300 | D | 4 |
| Biała Podlaska | 54,100 | C | 6 |
| Białogard | 24,300 | A | 2 |
| Białystok | 273,300 | B | 6 |
| Bielawa | 34,500 | E | 2 |
| Bielsk | 27,200 | C | 6 |
| Bielsko-Biała | 184,400 | F | 4 |
| Bieruń* | 21,900 | E | 4 |
| Biłgoraj | 26,500 | E | 6 |
| Bochnia* | 29,500 | E | 5 |
| Bogatynia* | 19,000 | E | 2 |
| Bolesławiec | 44,400 | D | 2 |
| Braniewo | 18,000 | A | 4 |
| Breslau, see Wrocław | | | |
| Brodnica | 26,800 | B | 4 |
| Brzeg | 39,100 | E | 3 |
| Busko-Zdrój | 18,100 | E | 5 |
| Bydgoszcz | 383,600 | B | 4 |
| Bytom | 232,200 | E | 4 |
| Chełm | 67,700 | D | 7 |
| Chełmno | 21,600 | B | 3 |
| Chodzież* | 20,100 | B | 3 |
| Chojnice | 38,900 | B | 4 |
| Chorzów | 131,500 | E | 4 |
| Chrzanów | 42,800 | E | 5 |
| Ciechanów | 44,700 | C | 4 |
| Cieszyn | 37,300 | F | |
| Czechowice-Dziedzice | 35,800 | E | 4 |
| Czeladź* | 37,400 | E | 4 |
| Czerwonka-Leszczyny* | 30,500 | E | 4 |
| Częstochowa | 258,700 | E | 4 |

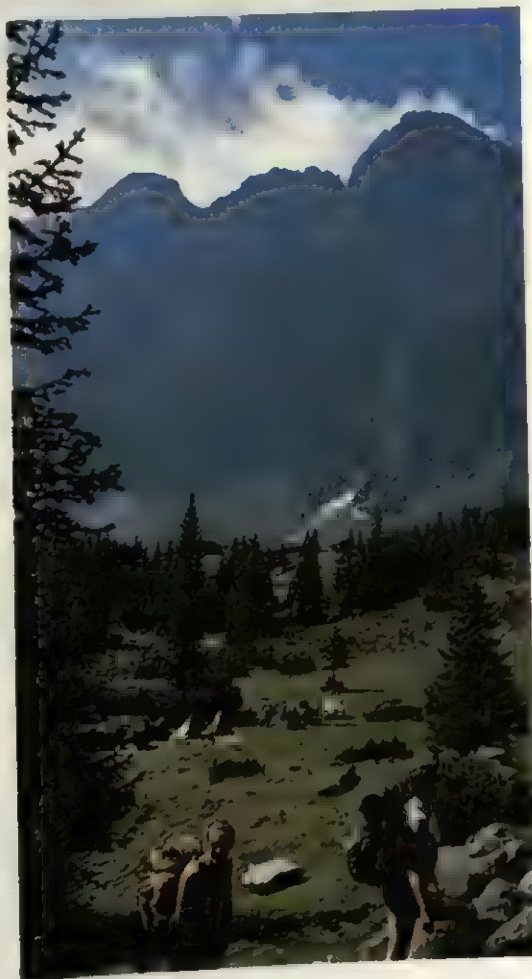
| | | |
|---|---|---|
| Dąbrowa Górnicza* | 139,200 E | 4 |
| Danzig, see Gdańsk | | |
| Dębica | 47,800 E | 5 |
| Dęblin | 19,300 D | 6 |
| Działdowo* | 20,300 B | 5 |
| Dzierżoniów | 38,000 E | 2 |
| Elbląg | 126,900 A | 4 |
| Ełk | 53,800 B | 6 |
| Gdańsk (Danzig) | 466,500 A | 4 |
| Gdynia | 251,800 A | 4 |
| Giżycko | 29,400 A | 5 |
| Gliwice | 215,700 E | 4 |
| Głogów | 73,900 D | 2 |
| Gniezno | 70,600 C | 3 |
| Goleniów | 22,300 B | 1 |
| Gorzów Wielkopolski | 125,200 C | 2 |
| Gostyń* | 20,000 C | 3 |
| Gostynin* | 19,800 C | 4 |
| Grajewo | 21,600 B | 6 |
| Grodzisk Mazowiecki* | 24 700 C | 5 |
| Grudziądz | 102,900 B | 4 |
| Gryfice | 17,600 B | 2 |
| Gryfino* | 21 100 B | 2 |
| Hajnówka* | 24,100 C | 6 |
| Hrubieszów | 19,900 D | 7 |
| Iława | 32,100 B | 4 |
| Inowrocław | 78,500 C | 3 |
| Jarocin | 25,300 C | 3 |
| Jarosław | 42,400 E | 6 |
| Jasło | 38,100 F | 5 |
| Jastrzębie-Zdrój | 104,600 E | 4 |
| Jawor | 25,100 D | 2 |
| Jaworzno* | 99,900 E | 4 |
| Jędrzejów | 18,200 E | 5 |
| Jelenia Góra | 93,500 D | 2 |
| Kalisz | 106,500 D | 3 |
| Kamienna Góra* | 23,500 E | 2 |
| Katowice | 366,900 E | 4 |
| Kędzierzyn* | 71 300 E | 3 |
| Kętrzyn | 30,600 A | 5 |
| Kęty* | 19,500 E | 4 |
| Kielce | 215,000 E | 5 |
| Kłodzko | 30,600 E | 2 |
| Kluczbork | 26,800 D | 3 |
| Knurów* | 46,000 E | 4 |
| Koło* | 23,500 C | 4 |
| Kołobrzeg | 46,000 A | 2 |
| Konin | 81,100 C | 3 |
| Końskie* | 22,100 D | 5 |
| Kościan | 24,400 C | 2 |
| Kościerzyna | 22,800 A | 3 |
| Koszalin | 109,800 A | 2 |
| Kozienice* | 21 200 D | 5 |
| Kraków | 751 300 E | 4 |
| Krapkowice* | 19,900 E | 3 |
| Kraśnik* | 37,000 D | 6 |
| Krasnystaw* | 20,400 D | 7 |
| Krosno | 50,100 F | 6 |
| Krotoszyn | 28,200 D | 3 |
| Kutno | 51,000 C | 4 |
| Kwidzyn | 37,400 B | 4 |
| Łask* | 19,900 D | 4 |
| Łaziska Górne* | 23,400 E | 4 |
| Lębork | 35,300 A | 3 |
| Łęczna* | 20,100 D | 6 |
| Legionowo | 50,800 C | 5 |
| Legnica | 106.100 D | 2 |
| Leszno | 59,500 D | 2 |
| Łódź | 844,900 D | 4 |
| Łomża | 60,700 B | 6 |
| Łowicz | 31,000 C | 4 |
| Lubań | 24,000 D | 2 |
| Lubartów* | 22.700 D | 6 |
| Lubin | 83 000 D | 2 |
| Lublin | 352,500 D | 6 |
| Lubliniec | 26,000 E | 4 |
| Luboń* | 20,100 C | 3 |
| Łuków | 31,700 C | 6 |
| Malbork | 40,000 A | 4 |
| Międzyrzecz | 20,300 C | 2 |
| Mielec | 63,300 E | 5 |
| Mikołów* | 37,300 E | 4 |
| Mińsk Mazowiecki | 34 500 C | 5 |
| Mława | 29,600 B | 5 |
| Mrągowo | 22,600 B | 5 |
| Mysłowice* | 94,600 E | 4 |
| Myszków | 33,800 E | 4 |
| Nakło nad Notecią | 20,100 B | 3 |
| Nowa Ruda | 27,400 E | 2 |
| Nowa Sól | 43,400 D | 2 |
| Nowy Dwór Mazowiecki* | 26,800 C | 5 |
| Nowy Sącz | 79,000 F | 5 |
| Nowy Targ | 33,000 F | 4 |
| Nysa | 47,800 E | 3 |
| Oława | 31,500 D | 3 |
| Oleśnica | 38,300 D | 3 |
| Olkusz* | 41,000 E | 4 |
| Olsztyn | 164,800 B | 5 |
| Opoczno* | 21,200 D | 4 |
| Opole | 128,900 E | 3 |
| Orzesze* | 18,200 E | 4 |
| Ostróda | 34,900 B | 4 |
| Ostrołęka | 51,800 B | 5 |
| Ostrów Mazowiecka | 21,100 C | 6 |
| Ostrów Wielkopolski | 74,000 D | 3 |
| Ostrowiec Świętokrzyski | 79,600 D | 5 |
| Oświęcim | 45,100 E | 4 |
| Otwock | 44,200 C | 5 |
| Ozorków | 21,900 C | 4 |
| Pabianice | 75,600 D | 4 |
| Piaseczno* | 24,700 C | 5 |
| Piekary Śląskie* | 68,500 E | 4 |
| Piła | 73,300 B | 3 |
| Plonki* | 21,600 D | 5 |
| Piotrków Trybunalski | 81,000 D | 4 |
| Plastów* | 23,500 C | 5 |
| Pleszew* | 18,100 C | 3 |
| Płock | 125,300 C | 4 |
| Płońsk* | 21,700 C | 5 |
| Police* | 35,000 B | 1 |
| Polkowice* | 21,100 D | 2 |
| Poznań | 589,700 C | 3 |
| Prudnik | 24,600 E | 3 |
| Pruszcz Gdański* | 21,500 A | 4 |
| Pruszków | 53,200 C | 5 |
| Przemysl | 69,200 F | 6 |
| Pszczyna* | 39,900 E | 4 |
| Puławy | 53,200 D | 6 |
| Pułtusk* | 18,200 C | 5 |
| Pyskowice* | 21,900 E | 4 |
| Racibórz | 65,300 E | 3 |
| Rawicz | 21,100 D | 3 |
| Radom | 229,700 D | 5 |
| Radomsko | 50,700 D | 4 |
| Ruda Śląska* | 171,6[illegible] E | 4 |
| [redacted] | 38,000 A | 3 |
| Rybnik | 144,800 E | 4 |
| Rzeszów | 154,800 E | 6 |
| Sandomierz | 24,700 E | 6 |
| Sanok | 40,800 F | 6 |
| Siedlce | 72,900 C | 6 |
| Siemianowice Śląskie* | 81,200 E | 4 |
| Sieradz* | 43,600 D | 4 |
| Sierpc | 19,500 C | 4 |
| Skarżysko-Kamienna | 51,200 D | 5 |
| Skawina* | 24,000 E | 4 |
| Skierniewice | 46,700 C | 5 |
| Słupsk | 102,400 A | 3 |
| Sochaczew | 39,000 C | 5 |
| Sokółka* | 19,900 B | 6 |
| Sopot | 45,800 A | 4 |
| Sosnowiec | 259,000 E | 4 |
| Śrem | 28,600 C | 3 |
| Środa Wielkopolksa* | 20,800 C | 3 |
| Stalowa Wola | 71,000 E | 6 |
| Starachowice | 56,900 D | 5 |
| Stargard Szczeciński | 71,600 B | 2 |
| Starogard Gdański | 49,800 A | 4 |
| Stettin, see Szczecin | | |
| Strzelce Opolskie* | 21,900 E | 3 |
| Suwałki | 62,800 A | 6 |
| Swarzedz* | 23,400 C | 3 |
| Świdnica | 63,800 D | 2 |
| Świdnik | 40,600 D | 6 |
| Świebodzice* | 24,800 E | 2 |
| Świebodzin | 22,400 C | 2 |
| Świecie* | 26,600 B | 3 |
| Świetochłowice* | 60,600 E | 4 |
| Świnoujście | 43,600 A | 1 |
| Szczecin (Stettin) | 414,200 B | 1 |
| Szczecinek | 41,800 B | 2 |
| Szczytno | 27,400 B | 5 |
| Tarnobrzeg | 49,500 E | 5 |
| Tarnów | 121,900 E | 5 |
| Tarnowskie Góry* | 74,400 E | 4 |
| Tczew | 59,900 A | 4 |
| Tomaszów Lubelski | 20,800 E | 7 |
| Tomaszów Mazowiecki | 69,900 D | 4 |
| Toruń | 202,000 B | 4 |
| Turek | 29,600 C | 3 |
| Trzebinia* | 20,400 E | 4 |
| Tychy | 138,800 E | 4 |
| Wadowice* | 19,400 E | 4 |
| Wągrowiec | 23 500 C | 3 |
| Wałbrzych | 141,200 E | 2 |
| Wałcz | 26,900 B | 2 |
| Warsaw (Warszawa) | 1,653,300 C | 5 |
| Wieluń* | 25,100 D | 4 |
| Wejherowo | 47,100 A | 3 |
| Włocławek | 122,800 C | 4 |
| Wodzisław Śląski* | 112,200 E | 4 |
| Wołomin* | 36,900 C | 5 |
| Wrocław (Breslau) | 643,600 D | 3 |
| Wrzesnia* | 28,300 C | 3 |
| Wyszków* | 24,600 C | 5 |
| Zabrze | 205,800 E | 4 |
| Żagań | 27,700 D | 2 |
| Zakopane | 28,600 F | 4 |
| Zambrów* | 22,800 B | 6 |
| Zamość | 63,100 E | 6 |
| Żary | 40,500 D | 1 |
| Zawiercie | 57,100 E | 4 |
| Zduńska Wola | 45,400 D | 4 |
| Zgierz | 59,200 D | 4 |
| Zgorzelec | 36,500 D | 1 |
| Zielona Góra | 114,900 C | 2 |
| Żory* | 67,300 E | 4 |
| Żyrardów | 43,000 C | 5 |
| Żywiec | 32,000 F | 4 |

*Does not appear on map, key shows general location.
Source: 1991 official estimates.

After completing the primary school programme, students may attend vocational schools or four-year secondary schools. Secondary school leavers must then pass entrance examinations for colleges of higher education. Poland has 10 universities, as well as many technical institutes and other specialized schools.

**Arts.** Poland has produced many outstanding artists, musicians, and writers. Cultural life in Poland flourished during the 1400's and 1500's. In the 1500's, the poets Mikołaj Rej and Jan Kochanowski were among the first writers to use the Polish language for their works.

Polish culture flourished during the 1800's, when the Polish national identity was threatened by the Germans and Russians. The paintings of Jan Matejko portrayed scenes from Polish history. The composer Frédéric Chopin wrote many works based on Polish dances, such as the mazurka and the polonaise. Another composer and pianist, Ignace Jan Paderewski, also became a leading Polish statesman. Outstanding Polish writers of the 1800's included the poet Adam Mickiewicz, the playwright Stanisław Wyspiański, and the novelist Henryk



**Camping and hiking** are popular recreational activities in Poland. Many Poles like to holiday in the Tatra Mountains, *above,* which form part of the Carpathian range in southern Poland.

**Roman Catholicism** has a strong influence on the life of most Poles. A large majority of the people of Poland belong to the Roman Catholic Church. This picture shows Catholics at an outdoor religious ceremony in the city of Częstochowa.

Sienkiewicz. Sienkiewicz won a Nobel Prize in 1905 for his works, which included *Quo Vadis?* Another Polish novelist, Władysław Reymont, won a Nobel Prize in 1924 for *The Peasants* and other novels.

Beginning in the late 1940's, Poland's Communist leaders restricted cultural activity that did not promote Communist goals. But a series of antigovernment protests from the 1950's to the 1980's resulted in increases in cultural freedom. Today, there are few restrictions on cultural activities. The government has encouraged the preservation of traditional folk arts and music. Many Poles have won fame in the graphic arts, especially in poster design. Films are also a popular art form. Czeslaw Milosz, a Polish poet, won a Nobel Prize for literature in 1980.

### Land and climate

**Land regions.** Poland covers 312,677 square kilometres in central Europe. The country can be divided into seven land regions: (1) the Coastal Lowlands, (2) the Baltic Lakes Region, (3) the Central Plains, (4) the Polish Uplands, (5) the Carpathian Forelands, (6) the Sudeten Mountains, and (7) the Western Carpathian Mountains.

***The Coastal Lowlands*** extend in a narrow strip along the Baltic coast of northwestern Poland. Sandy beaches line much of the generally smooth coastline. The coast forms natural harbours at Gdańsk, Gdynia, and Szczecin. These three ports are the only major cities located in the lowlands.

***The Baltic Lakes Region*** covers most of northern Poland. This scenic, hilly area has thousands of small lakes. Forests and *peat bogs* (swamps made up of decayed plants) cover parts of the area. Most of the land is not good for farming, though some farmers grow potatoes and rye. Forestry is the area's most important industry.


**A huge poster** in the city of Wroclaw serves as an advertisement for the National Bank of Poland. Many Polish artists have won widespread fame for their bold, colourful poster designs.

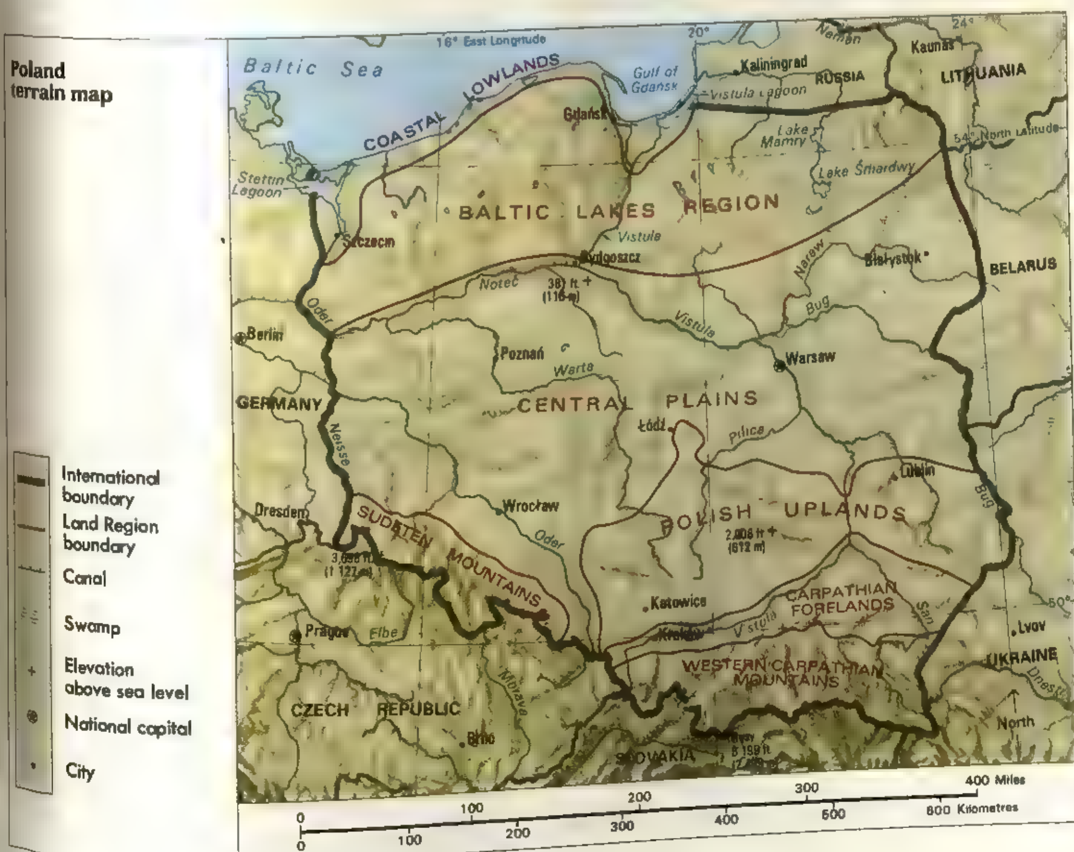
The Baltic Lakes Region is thinly populated. It is a popular holiday spot, where many Poles enjoy camping, hiking, and fishing.

***The Central Plains*** stretch across the entire width of Poland south of the Baltic Lakes Region. The low-lying plains make up Poland s major agricultural area, though other regions have richer soil. Farmers in the plains grow potatoes, rye, sugar beet, and other crops. The plains region has several of Poland's most important cities, including Poznań, Warsaw, and Wrocław.

***The Polish Uplands*** consist of hills, low mountains, and plateaus that rise south of the plains region. The densely populated uplands contain most of Poland's mineral wealth and much of its richest farmland. One of the world's largest coal fields lies around the city of Katowice. Coal-mining and metal-processing industries have made the Katowice area the most highly industrialized region in Poland. Copper, lead, and zinc are also found in the uplands. Fertile soil covers much of the area, especially in the east. Maize, potatoes, and wheat rank among the region's major crops.

***The Carpathian Forelands*** lie within the branches of the Vistula and San rivers in southeastern Poland. Much of this region is densely populated. Crops thrive in the rich soil that covers parts of the gently rolling forelands. Iron and steel industries have developed in the area around Kraków, the region's most important manufacturing centre.

**Gently rolling hills** cover much of southern Poland. This area has much of the country's best farmland. Farmers in southern Poland grow a variety of crops. In addition, some of the land is used to graze livestock.



***The Sudeten Mountains*** border southwestern Poland. Forests cover the rounded peaks of the Sudetens, most of which lie less than 1,500 metres above sea level. The valleys and foothills are used for crops and pastureland. Textile industries operate in many of the small cities and towns of the Sudetens.

***The Western Carpathian Mountains*** form the southernmost region of Poland. These steep, scenic mountains rise up to 2,499 metres at Rysy peak, the highest point in Poland. Rural towns and villages are scattered throughout the region. Bears, wildcats, and other animals live in the thickly forested mountains, and the region has several national parks.

**Rivers and canals** form a network of navigable waterways in Poland. The longest river, the Vistula, flows 1,086 kilometres from the Western Carpathians to the Baltic Sea. Other important rivers include the Bug, the Oder, and the Warta.

**Climate** varies greatly from one part of Poland to another. In general, the coast has milder weather than the inland regions, and the mountainous zones are cooler than the lowlands. Temperatures throughout Poland average −3° C in January and 23° C in July. The average annual *precipitation* (rain, snow, and other forms of moisture) totals about 60 centimetres.

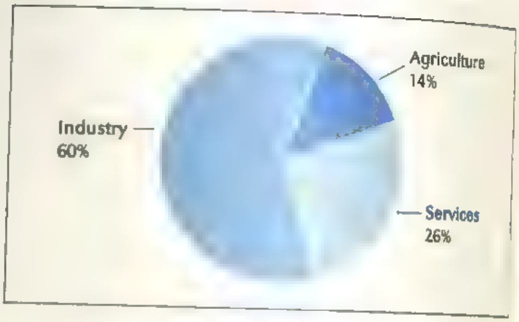
## Economy

Before World War II (1939-1945), Poland's economy depended largely on agriculture, which employed about 60 per cent of all Polish workers. After the war, the country's Communist leaders stressed the development of industry. New industrial regions were established around Kraków, Warsaw, and other cities. Today, industry employs about 36 per cent of all Polish workers, and agriculture employs about 25 per cent.

Most of Poland's industrial output consists of *capital goods,* such as factory equipment. The country does not produce enough *consumer goods,* such as clothing and furniture, to satisfy the people's demands. As a result, the people of Poland have a lower standard of living than do the people of most other industrial nations.

**Heavy industries,** such as the production of iron and steel, account for most of Poland's industrial output. The steelworks shown above form part of an industrial complex that was developed around the city of Kraków after World War II.

### Poland's production




Poland's production is reported in terms of its *net material product* (NMP). The NMP is the total value of goods and of services used in the production of those goods by a country in a year. Poland's NMP was 73,934,000,000 U.S. dollars in 1989.

### Production and workers by economic activities

| Economic activities | Per cent of NMP produced | Employed workers: Number of people | Employed workers: Per cent of total |
|---|---|---|---|
| Manufacturing & mining | 50 | 5,295,300 | 28 |
| Trade | 19 | 1,787,000 | 10 |
| Agriculture & forestry | 14 | 4,729,000 | 25 |
| Construction | 10 | 1,432,300 | 8 |
| Transportation & communication | 5 | 1,303,200 | 7 |
| Community, social, & personal services | — | 3,066,600 | 17 |
| Finance & insurance | — | 395,400 | 2 |
| Government | — | 334,000 | 2 |
| Other | 2 | 233,600 | 1 |
| Total | 100 | 18,576,400 | 100 |

Sources: United Nations; International Labour Office

**Natural resources.** Poland's most important natural resource is coal. One of the richest coal fields in the world lies in southern Poland. Poland also has deposits of copper, lead, salt, silver, sulphur, and zinc.

Farmland covers more than three-fifths of Poland. But much of the soil is of poor quality and must be fertilized. Forests cover about a quarter of the land.

**Industry.** The Communists established a system of government-owned industries in Poland. In 1990, the new government led by Solidarity began a programme of *privatization,* by which government-owned industries are sold to private owners. Many government industries were sold during the early 1990's. Today, about three-quarters of the industries are owned by the government.

The chief manufactured products of Poland include chemicals, food products, iron and steel, machinery, ships, and textiles. Poland is among the leading countries in the production of coal and silver.

**Agriculture.** Poland is among the world's leading producers of potatoes and rye. Other important crops include barley, sugar beet, and wheat. Farmers throughout Poland rear pigs. Cattle and sheep are reared mainly in the hilly regions of the south.

In 1948, the Polish Communist government began to take control of much farmland. Farmers were forced to give up their land and join collective farms, managed by the government. But many farmers resisted, and the collectivization programme ended in the 1950's. Today, private farms occupy 75 per cent of Poland's farmland. Most of the rest of the farmland consists of government-owned state farms. Collective farms account for only about 5 per cent of Poland's farmland. The average size of the private farms is about 5 hectares.

**Service industries** are those economic activities that produce services, not goods. The leading employer among service industries in Poland is the community, social, and personal services group. It includes such economic activities as education, engineering, and health care. The second largest employer among Polish service industries is trade. Other service industries include transportation and communication, government, and finance and insurance.

**Transportation and communication.** Railways provide the chief means of transportation in Poland. The railway network links most Polish cities and towns. Poland has an extensive system of roads. The country has an average of about 1 car for every 10 people. Poland's chief seaports are Gdańsk, Gdynia, and Szczecin. Polish Airlines (LOT), the country's only airline, operates domestic and international flights. Poland's chief airport is at Warsaw.

About 40 daily newspapers are published in Poland. The country has an average of about 1 radio for every 3 people and 1 television set for every 4 people.

**Foreign trade.** Poland's leading trade partners include many western European countries, such as Austria, Germany, Italy, and the United Kingdom. Poland's chief exports include coal, food products, machinery, ships, and sulphur. The country imports cotton, food products, iron ore, machinery, natural gas, petroleum, wool, and other goods.

## History

Slavic tribes probably lived in what is now Poland as early as 2000 B.C. During the A.D. 800's, several of the tribes united under the Polane, one of the largest groups in the area.

**The early Polish state.** Members of the Piast family became the first rulers of Poland. By the mid-900's, Prince Mieszko I ruled over most of the land along the Vistula and Oder rivers. His son, Bolesław I, conquered parts of what are now the Czech Republic, Germany, Slovakia, and Ukraine. In 1025, Bolesław was crowned the first king of Poland. After his death later that year, Poland went through periods of warfare and disunity. By the mid-1100's, it had broken up into several sections, each ruled by a different noble.

During the 1200's, various peoples invaded and conquered parts of Poland. Most of the country was finally reunified in the early 1300's. Casimir the Great, the last Piast monarch, ruled Poland from 1333 to 1370. He formed a strong central government, strengthened the economy, and encouraged cultural life.

**The Polish empire.** In 1386, Queen Jadwiga of Poland married Władysław Jagiełło, the Grand Duke of Lithuania. Jagiełło ruled both Poland and Lithuania as king, but each country remained largely self-governing.

Jagiellonian kings ruled Poland for nearly 200 years. Under their leadership, Poland expanded its territory and made important advances in its cultural, economic, and political development. The Polish empire reached its height during the 1500's, when it covered a large part of central and eastern Europe, including Ukraine and Belarus. In 1493, the first national parliament of Poland was established. Poland and Lithuania were united under a single parliament in 1569.

**The decline of Poland.** In spite of the advances of the Jagiellonian period, signs of strain developed after the mid-1500's. The monarchy began to lose power to the nobles, who dominated the parliament. After the death of the last Jagiellonian monarch in 1572, Polish kings were elected by the nobles. Some of the elected kings were foreigners, who proved to be ineffective rulers. Rivalries among the nobles weakened the parliament, and a number of costly wars ruined the country's economy.

Poland lost much of its territory in Ukraine as a result of a rebellion there in 1648. In 1655, Sweden won control over most of Poland's Baltic provinces. A series of wars with Turkey finally ended with a Polish victory at the Battle of Vienna in 1683.

**The partitions.** Poland's decline continued into the 1700's. In 1772, Austria, Prussia, and Russia took advantage of Poland's weakness and *partitioned* (divided) Polish territory among themselves. Austria seized land in southern Poland; Prussia took land in the west; and Russia took land in the east. As a result, Poland lost about a third of its territory and half its population.

After the first partition, the Polish government adopted a series of reform measures to stop the country's decay. In 1791, a new constitution restored the hereditary monarchy. But the reforms came too late. In 1793, Prussia and Russia seized additional territory in eastern and western Poland. This second partition led to an uprising among Poles in 1794. Polish forces under Thaddeus Kosciuszko fought Russian and Prussian troops, but were defeated. Austria, Prussia, and Russia carried out the third partition of Poland in 1795, dividing what remained of the country among themselves. Poland no longer existed as a separate country.

**Important dates in Poland**

| | |
|---|---|
| **A.D. 800's** | Slavic tribes in what is now Poland united under the Polane. |
| **1025** | Bolesław I was crowned the first king of Poland. |
| **1386** | The Jagiellonian dynasty was founded. |
| **1500's** | The Polish empire reached the height of its power. |
| **1772** | Austria, Prussia, and Russia partitioned Poland. |
| **1793** | Prussia and Russia partitioned Poland. |
| **1795** | The third partition of Poland ended its existence as a separate state. |
| **1918** | Poland proclaimed itself an independent republic. |
| **1939** | Germany and the U.S.S.R. invaded and partitioned Poland. |
| **1945** | A Communist-dominated government was formed, and Poland's present-day boundaries were established. |
| **1989** | Poland held its freest election since the Communists took control. Non-Communist candidates received great support in the elections. |
| **1990** | Poland's Communist party was dissolved. |

After 1795, many Poles joined the French forces of Napoleon Bonaparte to fight against Austria and Prussia. In 1807, Napoleon gained control of Prussian Poland and made it into a Polish state called the Grand Duchy of Warsaw. But after Napoleon's final defeat in 1815, Poland was again divided among Austria, Prussia, and Russia. A small, self-governing Kingdom of Poland was established under Russian control.

**The struggle against foreign rule.** In 1830, Poles in the Kingdom of Poland rebelled against the Russians. But Russia crushed the revolt and took away the kingdom's self-governing powers. Other unsuccessful revolts were launched against Austria and Prussia. After a second revolt in the Kingdom of Poland in 1863, Russia tried to destroy Polish culture by making Russian the official language of the region. After 1871, when Prussia formed the German Empire, Poles under Prussian control were forced to adopt the German language.

Poles under Austrian rule won some self-government in the late 1800's. In the 1880's and 1890's, Polish political parties were founded in all three parts of Poland.

**World War I and independence.** After the outbreak of World War I in 1914, Piłsudski led Polish forces on the side of Austria against Russia. The Russians were driven out of most of Poland by 1915, and the following year, Austria and Germany established a small Polish kingdom under their protection. In 1917, Dmowski formed the Polish National Committee in Paris to win Allied support for an independent Poland. After the Allied victory in 1918, an independent Polish republic was proclaimed. Piłsudski became the first chief of state.

Under the 1919 Treaty of Versailles, Poland regained large amounts of territory from Germany. The port of Gdańsk was made the Free City of Danzig under the supervision of the League of Nations (see **Versailles, Treaty of**). The return of land in Pomerania, a region along the Baltic coast, gave Poland access to the sea. In the east, Poland tried to reestablish its prepartition boundary with Russia. This led to a war with Russia in 1920. The 1921 Treaty of Riga established a border that gave Poland some of its prepartition land.

**Rebuilding the Polish nation.** The new Polish state faced many problems. Its leaders had to unify three regions that had been separate for more than 100 years. About a third of its population consisted of minority groups, some of whom resented Polish rule. In addition, the partitions and World War I had disrupted the country's economy. During the 1920's and 1930's, Poland slowly rebuilt its economy and developed uniform systems of government, transportation, and education.

The 1921 Constitution of Poland provided for a democratic government. But many political parties competed for power, and the government was unstable. In 1926, Józef Piłsudski, who had retired from politics in 1923, led a military overthrow of the government. He then took control of the government. In 1935, Poland adopted a new constitution that confirmed many of Piłsudski's unrestricted powers. Piłsudski died in 1935. But his successors continued the policy of absolute rule.

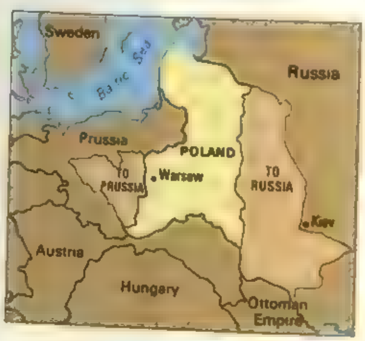
In the 1930's, Poland began to be threatened by the growing military strength of Germany and the Union of Soviet Socialist Republics (U.S.S.R.). The U.S.S.R. had been formed in 1922 under Russia's leadership, and it lasted until 1991. In 1939, Adolf Hitler demanded that Danzig (Gdańsk) be given to Germany. He also demanded transportation rights across eastern Pomerania. The Poles resisted Hitler's demands. Britain and France had signed an alliance pact with Poland in 1921, which pledged to defend Poland if its independence was directly threatened.

**World War II.** In August 1939, Germany and the U.S.S.R. signed a treaty that included a secret agreement to partition Poland. On September 1, Germany attacked Poland. Britain and France then declared war on Germany. The U.S.S.R. invaded Poland on September 17. Although the Poles fought bravely, they were defeated within a month. Germany and the U.S.S.R. then divided Poland. In 1941, Germany attacked the U.S.S.R. and seized all of Poland.

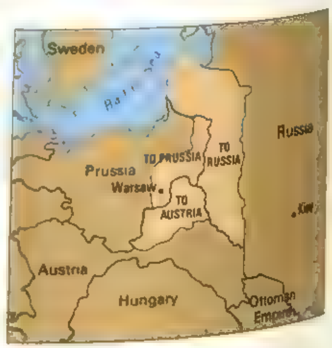
Shortly after the fall of Poland, a Polish government-in-exile was formed in Paris. Later, it was moved to London. Polish armed forces joined Allied forces in many campaigns during World War I. In addition, an underground Home Army operated inside Poland against the Germans.

After the German attack against the U.S.S.R. in 1941, Polish Communists formed an exile centre in the U.S.S.R. Poles under the command of the U.S.S.R. fought against Germany on the eastern front. The Communists also formed their own small underground movement. In 1942, they established the Polish Communist Party. Władysław Gomułka became the party leader in 1943.


**The first partition,** in 1772, resulted in Poland losing about a third of its land to the neighbouring countries of Austria, Prussia, and Russia.




**In the second partition,** in 1793, Russia took most of the regions of Lithuania and the Ukraine in eastern Poland. Prussia took most of western Poland.




**In the third partition,** in 1795, Austria, Prussia, and Russia occupied what remained of Poland. Poland ceased to exist as an independent nation.

In 1944, the Soviet army invaded Poland and began to drive out the Germans. Also in 1944, the Home Army staged an uprising against the Germans in Warsaw. But after two months, the Home Army had to surrender. That same year, a Polish Committee of National Liberation was formed in Lublin. The U.S.S.R. recognized the committee, which consisted almost entirely of Communists, as the provisional government of Poland. At the 1945 Yalta Conference, the Allies agreed to recognize the committee after it was expanded to include representatives of the London government-in-exile and other non-Communist groups (see **Yalta Conference**).

Poland suffered widespread death and destruction during the war. Much of Warsaw and other cities were destroyed. Millions of Poles, including most Polish Jews, were put into concentration camps when the U.S.S.R. and Germany occupied Poland. Between 1939 and 1945, over 6 million Poles died. About half were Jews.

Agreements reached at the end of the war shifted Poland's borders westward, and millions of Poles were resettled. The U.S.S.R. kept most of eastern Poland. In return, Poland received the German lands east of the Oder and Neisse rivers, including major industrial regions.

**Communist rule** was opposed by most Poles. But the Communists used police power and other methods to crush resistance. Communist-controlled elections in 1947 gave them a large majority in the new legislature. By 1948, Communist rule was firmly established.

During the late 1940's, the U.S.S.R. gained increasing influence over the Polish government. In 1949, a U.S.S.R. military officer, Konstantin Rokossovsky, was made Poland's defence minister. Polish Communists suspected of disloyalty to the U.S.S.R. were removed from power. They included Władysław Gomułka, who, as first secretary, held the most powerful post in Poland. He was removed from his post in 1948 and imprisoned in 1951. In 1952, Poland adopted a constitution patterned after that of the U.S.S.R. The government took control of industries and forced farmers to give up their land and work on collective farms. As part of an antireligion campaign, the Communists imprisoned Stefan Cardinal Wyszyński, head of the Roman Catholic Church in Poland.

During the 1950's, many Poles began to express discontent with government policies and resentment of domination by the U.S.S.R. In 1956, workers in Poznań and other cities staged antigovernment riots. Władysław Gomułka was then freed from prison and again became head of the Communist Party. He ended the forced takeover of farmland and eased the campaign against religion. Cardinal Wyszyński was released from prison, and defence minister Rokossovsky was dismissed.

In the 1960's, Polish intellectuals protested against government limits on freedom of expression, and new disputes erupted between the government and the Catholic Church. In 1970, strikes and riots broke out in Gdańsk and other cities. Thousands of Poles demanded better living conditions and economic and political reforms. After several days of riots, Gomułka resigned from his post. Edward Gierek became the Communist Party leader.

**Recent developments.** Gierek's leadership brought better relations between the government and the Catholic Church. Although Poland remained a loyal ally of the U.S.S.R., its government took steps during the 1970's to improve relations with non-Communist countries.

In 1978, Karol Cardinal Wojtyla, a Polish cardinal and the archbishop of Kraków, was elected pope of the Roman Catholic Church. He took the name of John Paul II. He became the first Polish pope and the first non-Italian pope since 1523. He visited Poland in 1979, 1983, and 1987. John Paul II called on the Polish government to allow greater freedom to the Polish people.

Poland has struggled with high prices and shortages of food and consumer goods since the mid-1970's. In 1976, Poles rioted after the government announced big increases in food prices. Government leaders then deferred the increases. Economic conditions worsened in the late 1970's. In the summer of 1980, thousands of workers in Gdańsk and other cities went on strike. They demanded higher pay, free trade unions, and political reforms. Communist leaders promised to meet many of the demands. In September, the Central Committee forced Gierek to resign and elected Stanislaw Kania to replace him. In November, the Polish government recognized Solidarity, an organization of free trade unions. This was the first time a Communist country recognized a labour organization that was independent of the Communist Party. Lech Walesa headed Solidarity.

Economic problems, including food shortages, increased. In October 1981, the Central Committee made Kania resign and elected Wojciech Jaruzelski, an army general, head of the Communist Party.


**In 1918,** Poland became an independent republic. Later, Austria, Germany, Lithuania, and Russia gave up large amounts of territory to Poland.


**In 1939,** at the beginning of World War II, Germany and the U.S.S.R. divided Poland almost in half. Poland again disappeared from the face of Europe.


**In 1945,** at the end of World War II, a new Poland was formed. Most of the land was retaken from Germany. The U.S.S.R. kept most of the land it had taken in 1939.

Jaruzelski's government faced continuing economic problems and demands by the people for economic improvements and greater political freedom. In December 1981, Jaruzelski imposed martial law, suspended Solidarity's activities, and had Walesa and hundreds of union leaders held as prisoners. In October 1982, the government officially outlawed Solidarity. Walesa and some of the other imprisoned Solidarity members were released in late 1982. The remaining prisoners were released over the next several years. Jaruzelski's government formally ended martial law in July 1983.

In 1989, the government reached an agreement with Solidarity that led to the legalization of the union and to changes in the structure of the government. Under the agreement, a Senate was added to the parliament and an office of president with broad powers was created. Non-Communist candidates were allowed to compete for all Senate seats and some lower house (Sejm) seats. The remaining lower house seats were reserved for members of the Communist Party and its allies. Candidates backed by Solidarity were the most successful in the elections. After the elections, parliament elected Jaruzelski as president. Mieczyslaw Rakowski succeeded Jaruzelski as Communist Party head. Parliament appointed Tadeusz Mazowiecki, a Solidarity leader, as prime minister. He became the first non-Communist prime minister since World War II. The new government began to end Communist controls over the lives of the people.

Also in 1989, the Polish government began a programme to sell government-owned industries to private owners. Much progress was made in this programme during the early 1990's. In 1990, Poland's Communist Party was dissolved.

In June 1990, Solidarity split into two opposing groups. One group supported Mazowiecki, and the other supported Walesa. In November, Mazowiecki, Walesa, and Stanislaw Tyminski ran in a presidential election. Mazowiecki finished third and then resigned as prime minister. Walesa won a runoff election against Tyminski in December 1990 and became Poland's new president. After the election, Walesa resigned as head of Solidarity. New parliamentary elections were held in October 1991. The 1989 system of reserving lower house seats for members of specific parties was abolished for the 1991 election. The Democratic Union, a party that formed out of Mazowiecki's branch of Solidarity, won the most seats in both the lower house and the Senate.

By 1993, people were discouraged by economic hardship brought on by the change to a free-market economy. New elections were held in 1993. The Democratic Left Alliance and the Polish Peasant Party won the most seats in the lower house and the Senate. Both of these parties include former Communist Party members. The two parties formed a coalition government and said they would continue economic reforms.


**A political rally** in the city of Gdynia showed support for Solidarity candidates in the 1989 elections. These elections were the first free elections held in Poland since the 1940's.

**Related articles** in *World Book* include:

Biographies

| | | |
|---|---|---|
| Chopin, Frédéric F. | John Paul II | Piłsudski, Józef |
| Conrad, Joseph | Kosciuszko, Thaddeus | Pulaski, Casimir |
| Copernicus, Nicolaus | Landowska, Wanda | Sienkiewicz, Henryk |
| Curie, Marie S. | Mazowiecki, Tadeusz | Stanislas, Saint |
| Gierek, Edward | Paderewski, Ignace J. | Walesa, Lech |
| Jaruzelski, Wojciech | | Wyszyński, Stefan Cardinal |
| John III Sobieski | | |

Cities

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| Gdańsk | Poznań | Wroclaw |
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| Łodź | Warsaw | |

History

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| Curzon Line | Teutonic Knights | World War II |
| Polish Corridor | Warsaw Pact | |

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| Carpathian Mountains | Pomerania |
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| Christmas (In Poland) | Slavs |

## Outline

I. **Government**
II. **People**
  A. Population and ancestry
  B. Way of life
  C. Religion
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III. **Land and climate**
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IV. **Economy**
  A. Natural resources
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  D. Service industries
  E. Transportation and communication
  F. Foreign trade
V. **History**

## Questions

What is Poland's most important natural resource?
In which year did Poland adopt Christianity?
How much of Poland's farmland is privately owned?
What is the *Sejm*?
Who were the Piasts?
Who was Wladyslaw Jagiello?
What are the chief manufactured products of Poland?
What are Poland's chief seaports?
When did the first partition of Poland take place?
Which Polish novelists have won Nobel Prizes?


**The hardy polar bear** lives along the frozen shores and in the icy waters of the Arctic Ocean. Polar bears have a thick, white coat, *left*, that blends in with the ice and snow. They swim strongly by paddling with their front legs and stretching their head forward, *right*.

**Polar bear** is a large, white bear of the North. Most polar bears live in regions where the mass of sea ice surrounding the North Pole breaks apart during the summer. They live chiefly along the northern coasts of Canada, Greenland, and the Soviet Union, and on islands of the Arctic Ocean. Polar bears also are found near the northern coast of Alaska. Polar bears hunt seals and other animals for food.

**Body.** A polar bear has a long body, neck, and head; short, furry ears; and sharp teeth. Adult male polar bears measure from about 2.5 to 3.5 metres long. Some of them weigh more than 450 kilograms. Most adult female polar bears are about 1.8 metres long and weigh 180 to 230 kilograms. Polar bears have dense, white fur. Their fur and thick layers of fat beneath their skin protect them from the bitter cold. Their white fur also serves as camouflage when hunting.

Polar bears have a keen sense of smell. They can smell food as much as 16 kilometres away and can sniff out seal dens that are covered by thick layers of snow and ice. Polar bears are also good climbers and excellent swimmers. On land, they can run for short bursts at speeds of more than 50 kilometres an hour.

**Habits.** Polar bears feed mainly on a small species of seal called the ringed seal. In the spring, polar bears hunt young seals by killing them at their dens. Later, seals are hunted at holes in the ice where they come up for air. After the ice breaks up, polar bears may surprise seals resting on floating ice by swimming up and pouncing on them. Polar bears also eat sea birds, lemmings, fish, berries, and grasses.

**A mother polar bear** guards her cubs. At birth, the cubs weigh only about 0.7 kilogram and are completely helpless. Most cubs live with their mother for the first 2 years.

Polar bears live in dens during the colder months. A pregnant female will usually occupy a den from October to April. She most often digs the den in a deep snowbank on the side of a hill or valley. In late November or early December, she gives birth to her young—usually twin cubs. At birth, polar bears measure only about 25 centimetres long and weigh about 0.7 kilogram. Most family groups of polar bears stay together for about two years. Wild polar bears may live up to 33 years and those in captivity may live a bit longer.

**Polar bears and people.** Although polar bears hunt other animals, they rarely kill people. People, however, threaten the survival of polar bears. Hunters have killed many polar bears for their attractive and valuable pelts. In the mid-1980's, there were only about 25,000 wild polar bears in the world. The Soviet Union, Canada, and other nations now restrict the number of polar bears hunters may kill, and the population is increasing.

**Scientific classification.** Polar bears belong to the family Ursidae. They are *Ursus maritimus*.

See also **Bear**.

**Polar exploration.** See **Exploration** (Polar exploration; table); **Antarctica** (Exploration); **Arctic**.

**Polaris.** See **North Star**.

**Polarization.** See **Polarized light**.

**Polarized light** consists of light waves that have a simple, orderly arrangement. The waves of ordinary light are arranged in a complex, disorderly manner. Ordinary light from the sun or a lamp is composed of disorderly waves that vibrate in *all* directions perpendicular to the light beam. But polarized light consists of orderly waves that vibrate in only *one* direction. Because of its orderly structure, polarized light can be used in ways in which ordinary light cannot. For example, the internal physical structure of many transparent materials can be seen with the aid of polarized light. Light polarizers are powerful tools that are used in science, industry, and daily life.

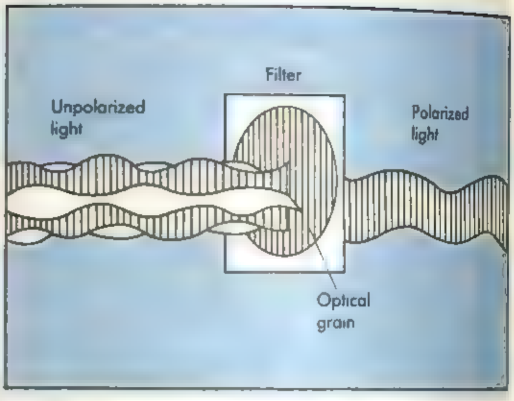
**How light is polarized.** To understand polarization, think of a light beam as a train of electromagnetic waves. The electromagnetic forces making up these waves vibrate in a direction perpendicular to the path of the beam. A rough example of these waves can be made by attaching a rope to a wall and shaking the other end. A train of waves will move along the length of the rope. Each part of the rope will vibrate in all directions perpendicular to its length. Waves that vibrate in this way are called *transverse waves*. See **Waves** (Transverse waves; illustration).

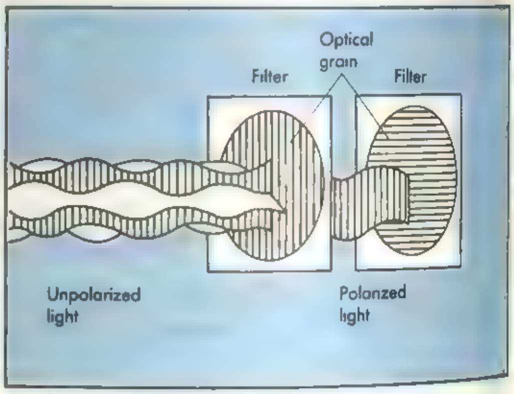
Polarized light vibrates in a single direction perpendicular to its path. Ordinary light can be polarized by passing it through a special *light-polarizing filter*. This filter allows only the waves that vibrate in one perpendicular direction to pass through. The structure of the light polarizing filter prevents the passage of light waves that vibrate in other perpendicular directions. In scientific terms, the light polarizing filter allows the *components* (parts) of the light waves that vibrate in one *vibration-direction* to pass through. The components of waves that vibrate in all other directions are held back. The light that passes through the light polarizing filter is called *polarized light*.

All the vibrations that pass through a polarizing filter vibrate in one direction—a direction parallel to the optical grain of the filter. The *optical grain* is the transmission axis of the filter. Polarized light can pass completely through a second polarizing filter whose transmission axis is parallel to that of the first polarizing filter. But if the second polarizer is rotated like a wheel, it will gradually dim the light that comes through it. The second polarizer will cut off the light entirely when its axis is "crossed" at 90° to the axis of the first polarizing filter. The dimming and cutting off occur because each polarizing filter absorbs all components of the light that do not vibrate parallel to the filter's axis. As a result, the brightness of the light beam is gradually reduced as the transmission axis of the second polarizer cuts across the transmission axis of the first.

Many applications of polarized light are based on this phenomenon. Much of the light around us is already polarized. Mirrorlike reflections from shiny horizontal surfaces, such as pavement and water, consist largely of light that has been horizontally polarized in the process of reflection. Polarized sunglasses, with their transmission axis set vertically, block the horizontally polarized light making up the bright reflections. Photographers use polarizing filters to cut down glare and reflections from shiny surfaces such as windows and water.

**How light is polarized**




Unpolarized light consists of waves that vibrate in all directions perpendicular to its path. A light polarizing filter allows only those waves that vibrate in a direction parallel to its optical grain to pass through, *top*. When the optical grain of a second filter is set at 90° to the grain of the first, the polarized light from the first filter is completely absorbed by the second, *bottom*.


**Without a polarizing filter,** a photograph looks like a double exposure because the camera picks up reflections.


**With a polarizing filter,** a photograph is clear because the filter placed over the camera lens absorbs the reflections.

**Polarizing materials.** The most widely used light polarizers consist of thin plastic sheets. A typical plastic sheet contains millions of long, slender, carefully aligned chains of iodine molecules. Each of these chains acts like an individual polarizing filter. Sheet polarizers have greatly extended the uses of polarized light because of their low cost and convenient size. Edwin H. Land, inventor of the Polaroid Land camera, invented the first sheet polarizer in 1928, when only 19 years old.

Some natural crystals, such as *tourmaline,* can polarize light. Tourmaline transmits the components that lie in one vibration-direction, and holds back others by absorbing them internally. Another natural polarizing crystal is *calcite,* or *Iceland spar.* It divides the light into two polarized beams that are at right angles to each other. *Nicol* prisms are cut from Iceland spar so that one of these beams is eliminated.

**Uses of polarized light.** Scientists have suggested that polarized glass be used for car headlights and windscreens to prevent driving glare from the lights of approaching cars.

Scientists can study the structure of many transparent materials with the aid of crossed polarizing filters. Microscopes equipped with polarizers show many colourless crystals and biology specimens in brilliant colour. A *polariscope,* an instrument equipped with polarizers, is used to find *strains* (weak spots) in glass objects such as spectacle lenses and laboratory glassware. Chemists can tell the type and amount of sugar in a solution by using a *saccharimeter,* a type of polariscope. Special polarizing filters that produce circularly polarized light are used on radarscopes to trap unwanted reflections.

See also **Huygens, Christiaan; Land, Edwin Herbert; Light** (How light behaves [Polarization]); **Tourmaline.**

**Polder.** See **Netherlands** (introduction; The land; pictures); **Belgium** (The land [Coastal and interior lowlands]).

**Pole.** The earth is constantly *rotating* (spinning) on an imaginary line called an *axis.* The axis passes through the centre of the earth and ends at either *pole.* The north end of the axis is the North Pole, 90 degrees north of the equator. The South Pole is the south end of the axis, 90 degrees south of the equator.

The term *pole* may be used to describe such a point on any revolving sphere. The term *celestial pole* refers to a point in the heavens about which the stars seem to revolve. A bright star that is near the north celestial pole is sometimes called the *Pole Star* or *North Star.*

In addition to the north and south geographic poles, the earth has north and south magnetic poles, which attract the north and south needles of compasses. The positions of the magnetic poles change over time. In 1985, the north magnetic pole was located near Ellef Ringnes Island in northern Canada, about 1,400 kilometres from the north geographic pole. The south magnetic pole was then just off the coast of Antarctica, near the French research station Dumont d' Urville, about 2,750 kilometres from the south geographic pole.

In physics, the word *pole* means the point where magnetic lines of force appear to originate. Magnetic poles that are unlike attract one another, and like magnetic poles repel each other.

See also **Earth** (The earth's shape and size); **Magnet and magnetism; North Pole; North Star; South Pole.**

**Pole, Reginald** (1500-1558), a Roman Catholic cardinal, became archbishop of Canterbury in 1556. Pole's cousin, Henry VIII, offered to make him archbishop of York in 1530, in return for supporting his divorce from Catherine of Aragon. Pole refused, and left England in 1532. Pope Paul III made Pole a cardinal in 1536. In Pole's absence, a *bill of attainder* was passed against him, depriving him of all rights and disgracing him and his family. After Mary became queen, Pole returned to England. He later became archbishop of Canterbury. Pole was born at Stourton Castle, in Staffordshire, England.

**Pole Star.** See **North Star.**

**Pole vault** is a men's event in athletics. An athlete uses a pole to propel his body over a crossbar set at a certain height. The equipment needed for pole-vaulting includes the pole, a crossbar, and two upright standards to support the crossbar. The pole can be made of any material, but all good vaulters use poles made of fi-

breglass. The pole is from 3.7 to 5.3 metres in length. The fundamentals of pole vaulting include (1) the grip, (2) the run, (3) the plant and take-off, (4) the swing, (5) the pull-up, and (6) clearing the bar.

**The grip** is important in pole-vaulting. The athlete must position his hands properly and place them at the ideal height on the pole. He places one hand about 60 to 90 centimetres below the other hand, and holds the pole parallel to the ground.

**The run** down the runway toward the crossbar is made almost at top speed, but the vaulter controls the run carefully. Markers along the runway allow the vaulter to gauge his stride and take-off position so that he takes off from the same foot and at the same place in every vault. During the run, the vaulter keeps his eye fixed on the box that is set in the ground beneath the crossbar.

**The plant and take-off.** The vaulter *plants* (places) the end of the pole in the box and slides his lower hand closer to his upper hand. As the speed obtained down the runway is transformed into upward motion, the pole bends. As it straightens, it helps the vaulter thrust himself upward.

**The swing and pull-up.** As the vaulter holds onto the rising pole and swings his body through the air, he pulls his knees up toward his chest and then shoots his feet up toward the bar. The swing and pull-up produce a handstand effect with the vaulter's chest next to the crossbar.

**Clearing the bar.** While the vaulter is in the handstand position, his feet start down on the other side of the crossbar. This position of the body is essential for maximum height. The vaulter then pushes the pole away from him so it will not hit the crossbar and knock it down. As the vaulter releases the pole, he turns his thumbs inward to help prevent his elbows from hitting the crossbar.

For world championship figures in the pole vault, see the *tables* with the articles **Athletics** (jumping) and **Olympic Games** (track and field).

**Polecat** is a small mammal that belongs to the weasel family. There are three species of polecats: (1) the European polecat, found throughout Europe, (2) the steppe polecat, found in the plains of central Asia, and (3) the marbled polecat, found in the dry grasslands of southeastern Europe to western China. The North American skunks are often called polecats because their habits are similar to those of the European polecat.

Polecats prey mainly on mice, rats, and other rodents. They also feed on birds, eggs, rabbits, fish, reptiles, insects, amphibians, and fruit. Polecats are active mostly at night. They usually live in an underground burrow.

Polecats live alone, except during the mating season or when the female is raising her young. Five to eight young are born about 40 days after mating. They leave their mother after three months. When frightened, polecats discharge a strong-smelling fluid from scent glands under the tail. A polecat also uses this fluid to mark its *territory*, the area it will defend against intrusion from other polecats.

A polecat has a long, slender body and short legs. All three species have a "mask" of darker hair around their eyes. European polecats have dark outer fur, with lighter coloured underfur showing through. Their fur, known as *fitch*, was once used to make ceremonial robes in England. Male European polecats are 35 to 45 centimetres long, not including a tail of 10 to 20 centimetres. As with all polecat species, females are smaller. The domestic form of the European polecat is called a *ferret*.

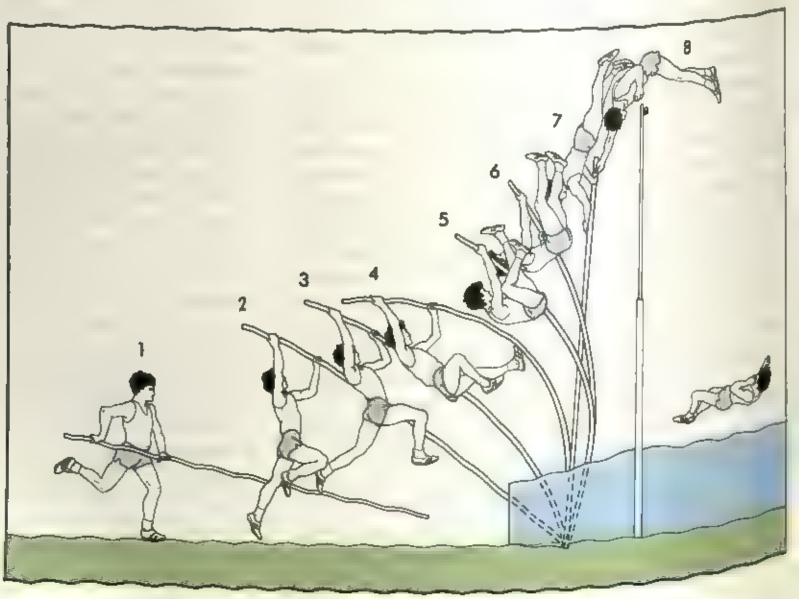
Steppe polecats are usually brown or yellowish, with a dark tail and legs. Males measure 55 to 65 centimetres long, not including a tail of 10 to 20 centimetres. Marbled polecats have a reddish-brown back, with patches of white or yellow. Male marbled polecats are 30 to 40 centimetres long, with a tail of 15 to 20 centimetres.

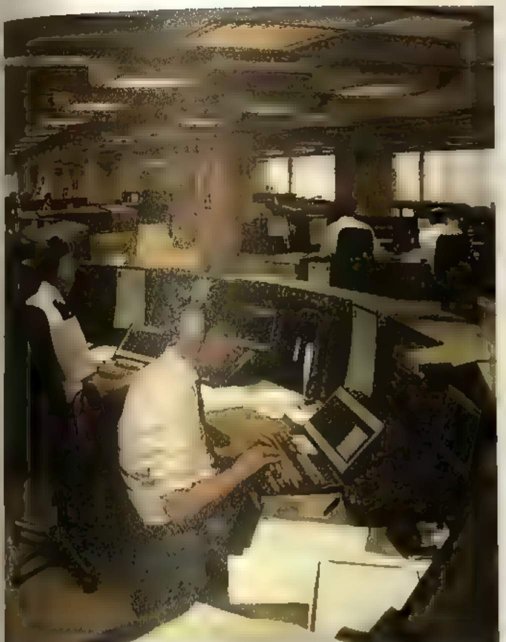
**Scientific classification.** Polecats belong to the family Mustelidae. The European polecat is *Mustela putorius*, the steppe polecat is *M. eversmanni*, and the marbled polecat is *Vormela peregusna*.

See also **Ferret**.

**Pole-vaulting technique**

Pole vaulting requires coordination, strength, and timing. The diagram on the right shows the basic steps in pole vaulting. (1) The vaulter sprints down the runway. (2 and 3) He places the end of the pole in the take-off box, bending the pole. (4 and 5) As the pole straightens, it provides the power to swing the vaulter up toward the bar. (6, 7, and 8) At the top of his jump, the vaulter twists his body to clear the bar.





Command and control rooms take emergency calls from the public and notify the nearest police of the need for help.

Uniformed river police enforce traffic regulations on the River Thames in London and patrol to detect crime.

# Police

**Police** are public employees who enforce the law and maintain order. They work to prevent crime and to protect the lives and property of the people of a community. Policemen and policewomen serve their communities in many ways. They patrol streets to guard against crime and to assist people with various problems. Police officers direct traffic to keep it running smoothly and safely. The police are often called to settle quarrels, find lost people, or aid accident victims. During floods, fires, and other disasters, they help provide shelter, transport, and protection for victims.

The police form part of a nation's *criminal justice system,* which also includes courts and prisons. Police officers enforce *criminal law,* which covers murder, robbery, burglary, and other crimes that threaten society. Police officers investigate such crimes and arrest suspected criminals. They also serve as witnesses in court trials.

Every nation in the world has a police system. Most countries have a number of separate police organizations, each responsible for policing a particular area, or a particular type of crime. Australia has 8 separate police forces, the United Kingdom has more than 50, and the United States has about 40,000 separate police agencies. Some countries have one police force, controlled and financed by the national government. For example, China, France, Ireland, and New Zealand each have a single, national police organization.

Police officers are called by a wide variety of popular names. In Britain and some other countries, they are called *coppers,* a word that may have originated from *cop,* meaning to seize or arrest. Police in the United States are often called *cops.* The word *cop* may have come from the initials *c.o.p.* (constable *on patrol*). Some experts believe *cop* is short for *copper,* a word that referred to the copper badges worn by police officers. At one time, British police officers were nicknamed *Peelers* or *bobbies,* after Sir Robert Peel, founder of the London Metropolitan Police. Other slang terms for the police include *the bill, the law,* and *the fuzz.*

## Police activities

**Uniformed patrols** are the major area of police work. Uniformed officers are assigned *beats* (areas or routes) to cover on foot, in squad cars, or on motorcycles. In some cities, they patrol on horseback, and in many river and harbour areas, police patrol in boats.

Patrol officers survey their beats repeatedly. Foot patrol officers often carry two-way pocket radios, and patrol cars are equipped with larger two-way radios. Officers may receive assignments over their radios to handle a car accident, investigate a reported crime, or help settle a family argument. If necessary, they may call the police station for assistance in handling an assignment. Patrol officers are often assigned to control crowds at sports meetings, processions, political gatherings, and other large public events.

Police officers may arrest a person they see committing a crime. They also may arrest a person if they have reasonable cause to suspect that the person is committing a crime or is about to commit one. But in some cases, police officers are required to get a court order called a *warrant* before making an arrest.

**Traffic patrols.** Traffic officers promote safety on streets and main roads. They normally wear uniforms, and patrol in cars or on motorcycles. Some police

forces use helicopters to survey traffic. Police on traffic duty may direct traffic; protect pedestrians; aid motorists; and enforce parking, speed, and other traffic laws. Traffic officers also investigate major traffic accidents and help ensure safety for other vehicles. In most countries, police on traffic patrols enforce insurance, licence, and tax regulations for motor vehicles and their drivers.

**Investigating crime** is the main work of detectives, who are sometimes called *plainclothes officers* because they do not wear uniforms. The detectives section usually has a special name, such as Criminal Investigation Branch (CIB) in Australian police forces or Criminal Investigation Department (CID) in Britain. Detectives try to discover who committed a crime, and to find the evidence necessary to convict the criminal in court.

In larger police forces, some detectives work in various specialized squads that deal with such crimes as murder, robbery, fraud, or the illegal sale of drugs. Murder case detectives may start their inquiry by searching for bloodstains, fingerprints, and weapons. Detectives question any witnesses, suspects, or others who may have information about the crime.

Various technical specialists in a police department assist the detectives in an investigation. Some of these specialists are police officers, but others are specially trained civilians. A photography unit may take pictures or video records of the crime scene and the evidence. Experts from a *police laboratory* collect and examine bloodstains, bullets, hair samples, fingerprints, weapons, and other evidence. Police laboratory experts may perform chemical tests to identify any unknown substance connected with the crime. The detectives in charge of an investigation supervise the technical specialists involved. Later, the reports of the detectives and the technical specialists are used in court.

Some plainclothes police officers are assigned to gather intelligence (information) about the activities of suspected criminals. The women and men who work in the criminal intelligence division of a police department are sometimes called undercover agents. They gather information on such criminal operations as the illegal sale of drugs. The reports of intelligence officers are used in developing plans to fight criminal activities.

**Juvenile and social work.** Officers in both plainclothes and uniformed branches do some work in which social objectives are more prominent than law enforcement. For example, some officers work with young people in clubs or other community activities. Other officers visit schools, or clubs for the general public, to talk about police work. Some police officers become involved in counselling and helping people with extreme problems, so that they are less likely to become involved in crime. The police also work with voluntary organizations and social workers to help the victims of crime.

**Records and communications.** The records bureau of a police department keeps files on all reported crimes, investigations, and arrests, and on various police activities. Many police departments use computers to process and store these records. Many countries also have centralized criminal, vehicle, and other records which can be referred to by officers in each police force.

The communications centre is another important unit of a police department. Its *command and control* room receives calls for help or reports of crimes and sends officers to the scene. Many larger police agencies use computers in this operation. When a report of a crime or a call for help comes into the control room, the information is typed on the *terminal* of a computer. A control room officer reviews the problem and sends the information to one or more available patrol cars. The patrol officers receive the information by radio or over terminals in their cars.

**Specialist activities.** Large police forces have various specialized units, which may include *search and rescue teams, dog handlers, bomb squads,* and *special weapons units.* Most members of such units work at other assignments until their special skills are needed. Some medium-sized and large police forces also have separate *data processing and research offices.*

***Search and rescue teams*** try to find people lost in forests, mountains, caves, or other out-of-the-way places. Members of these teams are trained in rock climbing, mountain survival, and other skills. They often use helicopters and aeroplanes in rescue missions.

Dog handlers work with dogs trained in special tasks such as catching fugitives, or finding drugs or bombs using the dogs' keen sense of smell. Dog handlers also do some specialized uniformed patrols, using the dogs as a deterrent against crime, or where their speed may be useful in catching suspects.

***Bomb squads*** respond to reports of bomb threats. They search the building or other place where a bomb supposedly has been planted. If they find a bomb, they try to prevent it from exploding or move it to a place where it cannot damage property or injure people.

***Special weapons units*** carry arms and are trained to handle dangerous situations involving armed criminals or terrorists. Members of these units are skilled in the use of high-powered rifles and other weapons. They know how to surround and capture criminals with the least possible danger to others.

**Police** are community helpers. These New South Wales police officers come into contact with people of all ages.

*Data processing and research offices* perform a variety of services. These offices may be staffed by police officers or by private citizens. Staff members compile crime statistics to help identify high-crime areas. They also prepare reports on present and future needs for personnel, equipment, or finance. In addition, they research new investigation techniques.

### Police around the world

In some countries, the national government directs the police system and maintains a national police force. Ireland, for example, has a national police force, and the uniform is exactly the same for all police officers. Other countries have a number of separate police forces, each with its own uniform.

In addition to law enforcement, police in some countries also have military duties, or are part of the military services. For such countries, figures of the number of police may be misleading or unavailable. Countries with links or overlap between police and military organizations include China, France, Pakistan, the Philippines, and South Africa.

All the world's police forces have a series of ranks. In most countries, officers at the lowest rank are called *constables*. More experienced officers who supervise constables' work include *sergeants, lieutenants, inspectors*, and *superintendents*. The head of a police force may be called a *chief constable, commissioner*, or *chief commissioner*.

**Australia** has eight separate police forces. Each of the six states, and the Northern Territory, has its own force. The federal police force maintains law and order in the Australian Capital Territory, and guards federal government property, including airports. Federal police also deal with crimes relating to federal laws, such as making counterfeit money. Australia has more than 30,000 police. The largest force is that of New South Wales.

Uniformed police in Australia work in such divisions as patrol, training, communications, and prosecutions. Uniformed police found in special units include water police, rescue squads, mounted units, and police bands. In addition, some uniformed police run youth clubs, thereby establishing friendly contact with youngsters. Most plainclothes police are detectives, belonging to the Criminal Investigation Branch (CIB). Within the CIB are special units, such as the drug squad, armed hold-up squad, and breaking squad. The New South Wales police force maintains a central collection of fingerprints for use by all police forces in Australia.

Australia's first police force was a night watch formed in 1789 to keep public order in Sydney. South Australia consolidated its force in 1838. Victoria united its force in 1853, Western Australia in 1861, New South Wales in 1862, Queensland in 1864, and Tasmania in 1899. The Northern Territory police date from 1911, and the federal police from 1960.

**Canada** has national, provincial, and city police forces. The Royal Canadian Mounted Police (RCMP) enforces federal laws throughout Canada. It serves as a provincial police force in all the provinces except Ontario and Quebec, which have their own forces. The RCMP is the only police force in the Yukon Territory and the Northwest Territories. It also provides police services on a contract basis to about 175 cities. Members of the RCMP are traditionally called "mounties," though they now ride horses only in special ceremonies. The RCMP has 19,000 staff cars. It was founded in 1873. See **Royal Canadian Mounted Police**.

**The Royal Canadian Mounted Police** enforces federal laws throughout Canada. This officer is checking the driving licence of a motorist she has stopped for a traffic offence.

**China** has a national police force called the People's Police. The force is directed locally by provincial public security bureaus. These bureaus function under the Ministry of Public Security, an agency of the national government. The People's Police is also supported by some branches of the People's Liberation Army, both in the cities and in rural areas.

**France** has a national law enforcement agency, the Sûreté Nationale. It forms part of the Ministry of the Interior. This organization operates in Paris and in cities and towns with a population of more than 10,000. Smaller towns and villages are policed by the Gendarmerie Nationale, governed by the Ministry of Defence. Another force controlled by the Ministry of the Interior is the Compagnies Republicaines de Securité (C.R.S.), a reserve force of highly trained, armed men for use in emergencies. French police originated in 1667 when Louis XIV appointed the first lieutenant of police to Paris. The combined forces of the French police total about 200,000.

**Germany** has separate police forces for each of the individual states. The states also maintain stand-by police, who assist the state police when necessary.

**Hong Kong's** citizens are protected by the Royal Hong Kong Police Force, numbering about 25,000. The force is headed by a commissioner and comprises four police districts. It was established in 1842.

**India** has a national law enforcement agency, the Indian Police. This is a central organization for all India, and there are separate forces for each of the 25 states and 7 union territories. In 1861, when India was under British rule, the Imperial Police Service was founded. It changed its name to the Indian Police Service in 1947, when India became independent.

**Ireland.** The national police force for the Republic of Ireland is the *Garda Síochána*, which has a total strength of about 11,000. The largest part of the force is the Dublin Metropolitan Area, and there are also 18 country divisions. Men at the lowest rank are known as *Gardaí*.

Members of the women's police are known as *Ban Ghardai.* The Garda Síochána, created in 1922, achieved its present general form in 1925.

**Malaysia.** The national police force is The Royal Malaysian Police and it was founded in 1807 in the town of Penang. There are 664 police stations and 658 police posts in Malaysia.

**New Zealand** has a single, national police force of 5,000 officers. Its present general structure dates from 1886. The first New Zealand police were a few constables appointed in 1840. An armed constabulary was formed in 1846. Various provincial police forces were combined into one armed constabulary in 1877. The unarmed force which exists today was formed in 1886.

**Pakistan.** The police force in Pakistan has been in existence since the declaration of independence in 1948. The police force consists of five separate bodies all headed by the Inspector General of Police. The Islamabad Police patrol the federal capital, Islamabad, and there are forces for each of the four provinces, Baluchistan, North-West Frontier Province, the Punjab and Sind.

**Philippines.** The Philippine National Police (PNP) is the national police force. It has 50,000 members and is part of the armed forces. The Philippine National Police is an integrated force which took responsibility for internal security in 1991.

**Russia.** Russia's police organization was in a state of transition in the early 1990's, following the breakup of the Soviet Union in December 1991. Some former Soviet institutions remained. Members of a national militia continued to provide general policing. The militia operated under a Ministry of Internal Affairs (MVD) that from 1992 owed its allegiance to the republic of Russia. The former Soviet Committee of State Security, the KGB, had also directed the work of the militia. It was abolished in October 1991.

**South Africa.** The national police force is known as the South African Police. In 1972 the force was divided into 18 divisions, with 80 police districts and 1,040 police stations. The total number of officers was recorded at 32,267. The South African Police are more involved in military work than the police forces in other countries. Any part of the police force may be used for national defence. It was formed following the Police Act of 1910.

**United Kingdom** has more than 150,000 policemen and policewomen, organized in 52 police forces. In England and Wales, there are 41 police forces organized in counties or groups of counties. In addition, London has the London Metropolitan Police and the City of London Police. Scotland has eight police forces, organized on a regional basis. The largest UK force is the London Metropolitan Police, with more than 26,000 employees.

Police forces cooperate with one another in the course of their work and share many central services. Regional crime squads pursue criminals in any of the areas forming a region. Specialist departments of the London Metropolitan Police include the murder squad, the fraud squad, and the criminal records office. The data and facilities of these departments are available to other departments and police forces. The Metropolitan Police has its headquarters at New Scotland Yard (see **Scotland Yard**).

The Royal Ulster Constabulary (RUC) is responsible for the policing of Northern Ireland. The RUC has three operational areas, each under the command of an assistant chief constable.

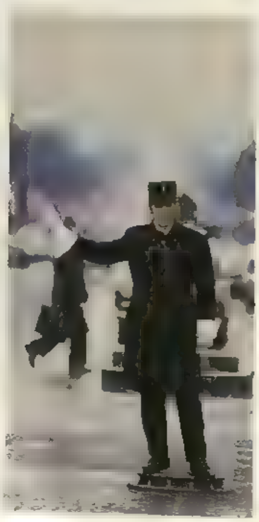
**United States** police agencies operate under city, county, state, or federal governments. Each agency is responsible only to its own division of government. Private police agencies are licensed by the states to provide certain types of police services. New York City has the largest city police department in the United States—about 29,000 police officers. A small town may have a police force of only one or two officers.

Some *city* police departments have specialized forces with certain limited powers. Such forces include airport police, housing police, park police, and transit police. In most *counties,* a sheriff, elected by the people, is the chief law enforcement officer. In some states, the sheriff's department provides police services on a contract basis to cities and towns within the county. State police enforce state laws and coordinate police activities within the state.

The most famous *federal* law enforcement agency is

**Police around the world**

China



France


Ghana

Mexico

the Federal Bureau of Investigation (FBI) (see **Federal Bureau of Investigation**). The FBI is the chief investigating branch of the United States Department of Justice. It investigates federal crimes and handles cases involving stolen money or property that has been taken from one state to another. The FBI also operates the National Crime Information Center (NCIC) in Washington, D.C. The NCIC is a computerized information system that stores records on wanted persons and stolen property.

Nine other major federal law enforcement agencies also have full police powers. They deal with matters such as customs, drug abuse, immigration, the postal service, international intelligence, and tax fraud.

### Interpol

Interpol is an international organization of police forces from almost all countries. Its official name is the *Inter*national Criminal *Pol*ice Organization. Members of Interpol exchange information about international criminals and cooperate in fighting such international crimes as counterfeiting, smuggling, and illegal buying and selling of weapons. The organization's staff keeps records of international crime, help in technical cooperation between members, and provide training and general consultation for member police forces.

Interpol is governed by a general assembly, in which each member has one vote. The assembly elects a president and 12 other members of the executive committee. The headquarters of Interpol are known as the General Secretariat and employ more than 250 staff. They are located in the city of Lyon in France.

The International Criminal Police Commission was founded in 1923, and based in Vienna. Its aim was to combat international crime, but almost all of its members were European. The commission was reorganized in 1946, and moved to Paris. By 1956, it had grown to 50 members, and it adopted the name Interpol along with the present constitution.

### History

In many ancient societies, the military forces served as police. In ancient Rome, for example, the military legions of the rulers enforced the law. Augustus, who became emperor in 27 B.C., formed a nonmilitary police force called the *vigiles.* The vigiles were responsible for keeping the peace and fighting fires in Rome.

During the A.D. 800's, England developed a system of law enforcement based on citizen responsibility. The people of every community were divided into *tithings* (groups of 10 families), and each tithing was responsible for the conduct of its members. Males who were more than 16 years old stood watch duty. When a serious crime occurred, all able-bodied men joined in a hue and cry (chase of the suspect). Each shire (county) was headed by a reeve (chief). The word sheriff is a shortened form of shire reeve.

In 1750, Henry Fielding, a magistrate and author, organized with his half-brother Sir John Fielding, the Bow Street Patrols to police the streets of London. They also formed the Bow Street Runners, who were the first paid detectives. These officers ran to the scene of a crime to capture the criminal and begin an investigation.

Sir Robert Peel, a British statesman, founded the Royal Irish Constabulary in 1814, and the London Metropolitan Police in 1829. The Metropolitan Police was organized along military lines, and its officers were carefully selected and trained. Peel is regarded as the father of modern, professional police organizations.

In North America, colonists established the English watch system in the towns and villages of New England. In the Southern Colonies, sheriffs were responsible for keeping the peace. Later, on the Western frontier, sheriffs and marshals enforced the law. The Texas Rangers, a band of mounted riflemen organized in the early 1800's, were the first form of state police. They fought Indians, patrolled the Mexican border, and tracked down cattle rustlers and other outlaws. In 1845, New York City combined its separate day and night watches into a single city police force modelled on the London Metropolitan Police.

During the early 1900's, August Vollmer, the police chief of Berkeley, California, gained fame as a police reformer. Vollmer brought about many changes in the police system. He urged reorganization of police departments, college education for police officers, and the use of scientific methods in police work.

From the 1960's to the 1990's, a number of developments occurred that changed the nature of police work. Police in many countries had to deal with riots and political demonstrations on a large scale. Many police forces began actively to recruit members of ethnic minority groups, and to improve relations between ethnic groups in the community. Women were recruited to the police on a larger scale and began to share fully in all police work. And the police worked increasingly with the public in crime prevention, particularly in the development of neighbourhood watch self-help groups.

**Related articles** in *World Book* include: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Bow Street Runners
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Footprinting
Handcuffs
Helicopter (For aerial observation)
Juvenile delinquency
Lie detector
Marshal
Peel, Sir Robert
Police laboratory
Police state
Prison
Probation
Radar (In controlling traffic speed and flow)
Riot
Secret police
Sheriff and bailiff
Thermography
Warrant
Wiretapping


### Outline

**A forensic scientist** compares bullet holes in glass, *left,* made by different types of guns. Such laboratory tests can help identify the type of gun used at the scene of a crime.

**Police laboratory** is a laboratory where experts analyse, identify, and interpret evidence connected with a crime. Glass splinters or a gun found on a suspect may be matched with broken glass or a bullet taken from the scene of a crime. The pattern of bloodstains near a body may indicate how a murder was committed. Other evidence includes documents, drugs and narcotics, fibres, fingerprints, hair, and soil. Large police forces maintain their own laboratories.

The technique of using scientific methods in solving crimes is called *forensic science.* A person who examines evidence in a police laboratory is known as a *forensic scientist.* The word *forensic* comes from the Latin word *forensis,* meaning *forum* or *court of law.*

Forensic science includes such specialities as *forensic psychiatry, forensic toxicology,* and *forensic pathology.* A forensic psychiatrist examines people suspected of a crime to determine whether they are legally sane. A forensic toxicologist identifies drugs and poisons in body tissues and determines their effects. A forensic pathologist performs postmortem examinations of victims to learn the cause of death.

### How evidence is handled

Forensic scientists and other investigators protect all evidence according to a security process called a *chain of evidence.* This process involves keeping a record of each person who handles the evidence. The chain begins at the scene of a crime and ends when the evidence is presented in court. If any evidence is left unguarded during this period, the judge may disallow its admission in court.

There are three steps in handling evidence: (1) collecting the evidence at the scene of a crime, (2) analysing the evidence in the laboratory, and (3) presenting the evidence in court.

**Collecting the evidence.** In most crimes, the evidence is collected either by police officers or by technicians associated with a police laboratory. But in such serious crimes as bank robbery and murder, forensic scientists themselves often go to the scene of a crime. They gather the evidence and, if possible, try to reconstruct the crime as it happened.

After a crime is discovered, the police *freeze* the scene. They permit nothing to be disturbed and keep unauthorized people out of the area.

Police investigators first photograph the scene from several angles to show the location of the evidence. Then a police artist or an investigator draws a *crime scene sketch,* which records the exact position of each piece of evidence according to precise measurement. The evidence is then collected.

The investigators use several methods to collect evidence. One of the most important methods is used to reveal fingerprints. First, the experts *dust* (brush) a surface with powder. The powder sticks to the oils left on a surface by one or more fingers. The print is photographed and then lifted from the surface with clear adhesive tape. The tape transfers the print to a piece of paper, which forms a permanent record. Fingerprints in blood, grease, or other visible material are photographed directly. See **Fingerprinting.**

To preserve other marks, such as footprints and tyre tracks, investigators first photograph them. Then a cast of the mark is made with plaster of Paris.

Investigators sometimes use special instruments to collect evidence. For example, a plastic container called a *vacuum trap* fits on the end of a vacuum cleaner hose and gathers small particles called *trace evidence.* Trace evidence includes fibres, hairs, sand, wood splinters, and particles of glass and paint. Larger evidence, such as bullets and firearms, is also collected. Samples are taken from blood or other body-fluid stains, if they are not on removable articles.

Investigators label each piece of evidence. The labels not only identify evidence but also help separate the evidence of one crime from that of another.

**Analysing the evidence.** A police laboratory uses several techniques to identify and analyse evidence. These techniques include microscopic examination, chemical treatments, and the use of special instruments.

Most police laboratories have several types of microscopes. A *bullet comparison microscope* is used to compare two or more bullets and to examine tool marks and determine their source (see **Ballistics** [Forensic ballistics]). Scientists identify minerals and drugs with a

**Fingerprints** are often an important source of evidence. Extensive fingerprint records are kept by police. A handheld digitizer, *left*, is used to convert fingerprints into digital records on a computer system.

polarizing microscope, which enlarges the crystal forms of each material. A *stereoscopic binocular microscope* helps sort trace evidence and is used to examine handwriting, typewriting, and samples of paint.

Handwriting can be identified by experts as belonging to a particular person if there is a genuine sample to compare it with. Forged signatures can also be detected, but it is not always possible to attribute them to a particular person. Typewriters can sometimes be identified by broken or distorted characters.

Scientists use chemicals to identify certain damaged evidence. For example, they use acid to restore partially erased serial numbers on some stolen property. They also use chemicals to determine the cause of an explosion or a fire. These chemicals detect traces of flammable substances, including petrol and paraffin, in the burned remains. Chemicals also help identify samples of blood and other body fluids. It is now possible to identify people not just by their blood group but also by the chemical makeup of their individual body cells.

Since the mid-1900's, many new instruments have been used in police laboratories. They include the *spectrophotometer* and the *gas chromatograph*. A spectrophotometer records light and heat rays that the human eye cannot detect. This instrument shows the pattern of the rays when they strike an object. Forgeries or illegal erasures on documents can be detected by comparing the pattern of rays in ink. A gas chromatograph separates the various components of a substance. The amount of each component is then measured. This method is used to determine the amount of alcohol in a person's blood. See **Chromatography**.

One of the newest techniques of analysing evidence is called *DNA fingerprinting*. In this method, investigators identify the persons to whom such substances as blood, hair, or semen belong by analysing the genetic material that the substances contain. The genetic material, called *deoxyribonucleic acid* (DNA), is present in most cells. See **Fingerprinting**.

**Presenting the evidence.** Forensic scientists are responsible for explaining the significance of evidence. They usually present their findings in written reports and may also give evidence in court. They are called *expert witnesses* because of their training and experience. Courts allow most witnesses to present only facts, but expert witnesses can give opinions based on evidence. They serve chiefly as witnesses for the prosecution.

### History

One of the first police laboratories was established in 1910 in Lyon, France, by Edmond Locard, a doctor. Locard helped work out various scientific methods to investigate crimes.

Alphonse Bertillon, a French statistician, developed a method of identifying persons according to their body measurements. This method, called the *Bertillon system*, was first used in Paris in 1879 and soon spread throughout the world.

Sir William J. Herschel, a British colonial administrator in India during the late 1800's, devised a workable method of fingerprint identification. Historians credit Sir Francis Galton, a British scientist, with developing Herschel's methods into a modern system of fingerprint identification in the 1880's. By the late 1910's, fingerprinting had replaced the Bertillon system almost entirely as a more accurate method of identification.

Hans Gross, an Austrian judge, probably invented the word *criminalistics*. In his book *Criminal Investigation* (1893), Gross declared that criminalistics was a science that should use a systematic approach to investigate crimes and analyse evidence.

See also **Footprinting**; **Voiceprint**.

**Police state** is any nation or other political unit in which the government allows its law enforcement agencies to maintain order through terror. In such a state, the police are not subject to laws or other restraints that would ordinarily limit their actions in a constitutional democracy. The police can spy on anyone without regard for privacy. They can also arrest, imprison, execute, or exile people for any reason.

In ancient times, the Greek city-state of Sparta had the most developed form of police state. During the 1900's, fascist and Communist countries have often used police state tactics.

See also **Secret police**.

**Polio.** See **Poliomyelitis**.

**Poliomyelitis,** also called *polio,* is a serious infection caused by a virus. The disease is sometimes called *infantile paralysis* because it may strike infants or children and lead to paralysis. In the past, epidemics of polio were common and were greatly feared because the disease left many of its victims paralysed for life. In the 1950's, however, a vaccine against the disease was introduced. Since then, polio has been nearly eliminated in developed countries.

**Kinds of poliomyelitis.** A polio virus may attack the nerve cells of the brain and spinal cord, causing paralysis. However, infection by a polio virus does not always result in severe illness. Some patients show only mild symptoms, such as fever, headache, sore throat, and vomiting. These symptoms may disappear after about 24 hours. Such symptoms are common in many kinds of ailments, and the doctor may not be able to diagnose the illness definitely as polio.

Severe polio attacks begin with the same symptoms as the mild attacks. The symptoms, however, do not disappear. Stiffness of the neck and back develops. The muscles become weak, and movement is difficult. Pain may occur in the back and legs, especially when these parts are stretched or straightened. If paralysis develops, the person may not be able to stand or walk.

Most people who develop polio do not become permanently paralysed. Paralysis can occur in many degrees and combinations. *Spinal poliomyelitis* is probably the most common form of polio. It occurs when polio viruses attack the nerve cells that control the muscles of the legs, arms, trunk, diaphragm, abdomen, and pelvis. *Bulbar paralysis* is the most serious form of the disease. It results from damage to the nerve cells of the brain stem. Some of these nerves control the muscles for swallowing and for moving the eyes, tongue, face, and neck. The nerves that control breathing and the circulation of body fluids may also be affected.

**Polio** was one of the most feared diseases until an effective vaccine was found in 1955. This photo from the 1950's shows a polio victim learning to walk with crutches and leg braces.

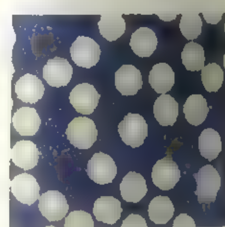
Some polio patients suffer new symptoms about 30 years or more after the initial attack. These symptoms include fatigue, muscle weakness, pain in the joints, and difficulty in breathing. Doctors are not sure what causes this condition, called *post-polio syndrome.*

**Cause of poliomyelitis.** There are three viruses that cause polio. They are called types I, II, and III.

Polio viruses can grow only in living cells. They get into the body through the nose and mouth and are carried to the intestines. Then they travel along the nerve fibres or are carried by the blood to the central nervous system. There, they enter a nerve cell and multiply so rapidly that they damage or kill the cell. Paralysis results when many cells are destroyed.

Scientists do not know exactly how polio spreads or why epidemics occur. Most authorities believe that the virus spreads from the nose, throat, and intestines of infected people. People who become infected by the virus do not always get polio. The virus has been found in apparently healthy people, especially during epidemics.

**Prevention of poliomyelitis.** There are two polio vaccines, and both protect against all three types of polio viruses. The first vaccine, developed by the American researcher Jonas E. Salk, is given by means of injection. It was declared safe and effective in 1955. The other polio vaccine was developed by Albert B. Sabin, another American researcher. It came into use in the early 1960's. The Sabin vaccine is an *oral vaccine*—that is, it can be taken by mouth.



**Polio virus**

Doctors recommend vaccination against polio early in life. Polio vaccine is typically administered in four doses—at 2 months of age, 4 months, 18 months, and just before children enter school, at 4 to 6 years of age.

**Treatment of poliomyelitis.** No drug has yet been found that can kill the polio virus or control its spread in the body. But the degree of recovery of many patients depends on immediate medical attention and good nursing care.

Complete rest in bed is perhaps the most important treatment. Doctors believe that fatigue may make the disease more severe. They use simple treatments, such as hot, moist bandages, to relieve pain. After the fever goes down, physiotherapists may gently move the patient's limbs to prevent deformities and painful tightening of the muscles. Later, more intensive exercises help strengthen and retrain the muscles. Even extensively paralysed patients can often develop enough movement to carry on many activities. Less severely disabled people usually resume most of their previous activities. Some may need splints, braces, or crutches to help them move about.

When breathing muscles are paralysed, doctors may use a mechanical device such as a respirator to help the patient breathe. About two-thirds of such patients recover their natural breathing.

**Related articles** in *World Book* include:

| | | |
|---|---|---|
| Disease (table) | Kenny, Elizabeth | Salk, Jonas |
| Enders, John | Sabin, Albert | Virus |
| Immune system | | |

**Polish** is a preparation that may be used on wood, metal, and other surfaces to produce a glossy finish. Most polishes are made of waxes mixed into liquid or salve. After the polish is spread over a surface and rubbed, everything evaporates but the wax, which forms a protective coating. Some polishes for metals remove tarnish. They act as cleaners as well as polishers. Some shoe polishes contain a dye that restores colour.

See also **Wax.**

**Polish Corridor** was a narrow strip of territory taken from Germany and granted to Poland after Germany's defeat in World War I (1914-1918). The Treaty of Versailles, which officially ended the war with Germany, es-


**Location of the Polish Corridor**

tablished the corridor in 1919 to give Poland direct access to the Baltic Sea. The area of the corridor was once part of a Polish region called Pomerelia. Prussia gained the territory in 1772. The region came under German control when Prussia became a German state in 1871. The largely agricultural region included the towns Bydgoszcz, Grudziądz, and Toruń and the seaport Gdynia.

The corridor separated the East Prussia area of Germany from the rest of Germany. About half the people in the region spoke German, and Germany and Poland came to dispute ownership of the territory. In 1939, Germany regained control of the corridor. The corridor and half of East Prussia became part of Poland in 1945.

See also **Gdańsk; Poland** (History).

**Polish Succession War.** See **Succession wars** (The War of the Polish Succession).

**Polishing.** See **Grinding and polishing.**

**Politburo** was the political bureau of the Central Committee that controlled the Communist Party of the Soviet Union from 1919 to 1991. Before 1990, the Politburo included the most powerful members of the Communist Party, and important decisions in the Soviet government needed its approval. But in 1990, the Politburo's power was greatly reduced when party leaders voted to limit its role to the development of party policy. In August 1991, several Communist officials failed in an attempt to overthrow Soviet president Mikhail Gorbachev and take control of the government. After the attempt, the Soviet parliament suspended all activities of the Communist Party, including those of the Politburo. In December 1991, the Soviet Union broke up into a number of independent states.

V. I. Lenin, the country's first leader, set up the Politburo in 1919. In 1952, the Politburo's name was changed to the Presidium of the Central Committee. In 1966, the Presidium was renamed the Politburo.

Lenin dominated the Politburo until his death in 1924. Joseph Stalin later gained control of it and replaced his political adversaries with handpicked associates. After Stalin's death in 1953, Nikita Khrushchev handled the Presidium in the same way.

The first Politburo had five members. But for many years, the Politburo usually had from 10 to 15 full members and from 7 to 10 *candidate* (nonvoting) members. In 1990, its membership was set at 24 full members. The name *Politburo* was also used for similar groups in other Communist countries.

See also **Communism; Union of Soviet Socialist Republics.**

**Political economy** is economics. See **Economics.**

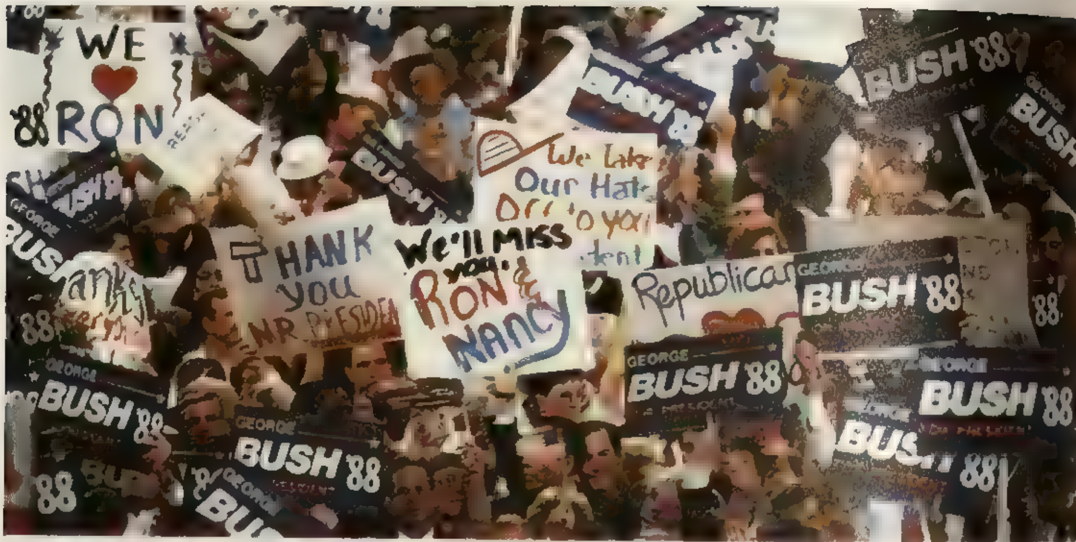
**Political parties** are organized groups of people who control, or seek to control, a government. In democratic countries, political parties compete against one another in elections to keep or gain control of a government. Political parties may be active at the national, state or provincial, and local levels.

Political parties are absolutely necessary to democratic government. Most modern democracies are *representative* democracies. That is, the people elect representatives to act as their agents in making and enforcing laws. In a representative democracy, some means is needed for nominating candidates for public office and for selecting issues for public debate. Political parties perform these functions. At election time, the people vote into office the candidates of their choice. Political parties are voluntary organizations. Some of these parties may have rules and membership subscriptions.

Most dictatorships allow only one political party—the party that controls the government. In countries with such a system, other parties are banned, or forbidden to put up candidates for public office. Such countries are called a *one-party* state.

## Party functions

In democratic countries, political parties perform several important tasks. (1) They select candidates to run for public office. (2) They help organize the government. (3) They provide opposition to the party in power. (4) They raise the funds needed to conduct election campaigns. Other functions of political parties in democracies include informing voters about public affairs and about problems that need government action. One of the political party's most important functions is to prepare a programme or set of policies. They propose to put this programme into action for the benefit of the country, if they gain or retain power at the next election. These policies are usually the subject of research and discussion within the party. They can concern almost any matter which the party considers important—such as conservation, control of public services, defence, economic plans, education, energy supplies, foreign policy, or the ownership




**At a national political convention in the U.S.A.,** delegates choose their party's candidates for president and vice president. This picture shows delegates demonstrating at the 1988 Republican Party convention in New Orleans. George Bush won the party's presidential nomination there.

of land and major industries. Such policies are sometimes discussed and voted on at a general meeting of party members. Sometimes, party policies are published as a manifesto, or as a plan for a certain number of years ahead, to present the arguments that the party's candidates will use to persuade voters to vote for them. In one-party nations, the chief functions of political parties are to select candidates for office and to organize the government.

**Selecting candidates.** In one-party states, the candidates which the party selects to run for office automatically win election because they have no opposition. In Communist countries, the Communist Party—usually the only party allowed—chooses the candidates for office.

In nations that have two or more parties, each party selects candidates for the various public offices. The voters then decide which candidates among the parties win office. Party leaders try to select candidates who have voter appeal and experience for the office.

Candidates are selected in various ways. In some parties they are chosen in meetings of party leaders called *caucuses* (see **Caucus**). In the United States, the two main political parties—the Democratic and Republican parties—hold national meetings or *conventions* to select nominees for the office of president and vice president (see **Political Convention**.) Each party's national convention meets only once every four years. The parties also have national committees, a national chairman, and a state committee in each state. At local level, there are county committees, and city, ward, and precinct organizations. Another way of choosing candidates for office is by primary elections (see **Primary Elections**). Candidates may also be chosen by meetings of local party members, who vote to choose which person shall represent their party in the next election in their voting area, or *constituency* (see **Elections**).

The leader of a political party is generally chosen in one of three main methods: by a convention, or by the votes of either the party's members of parliament or the total membership of the party.

**Organizing the government** is a major function of political parties. But how the parties do this depends on the government's established structure and on how the powers of government are divided.

***Unitary and federal systems.*** In countries that have a *unitary* system of government, such as France, Italy, and the United Kingdom (U.K.), the central government has most governmental powers, including control over local governments. In countries that have a *federal* system of government, such as Australia and Canada, the powers of government are divided between the central government and the state or provincial governments (see **Government** [Systems of government]). The political parties in countries with a unitary system concentrate on gaining control of and organizing the central government. The parties are thus basically national in their activities and are so organized. The political parties in countries with a federal system try to gain power to organize both the central government and the state or provincial governments. The parties are thus both national and state in their activities and organization.

***The presidential system.*** In a presidential system like that of the United States, the constitution provides for the separation of powers among the executive, legislative, and judicial branches. The president, therefore, is not a member of U.S. Congress, nor are the Cabinet members. The president is elected by the people through the Electoral College and may be of a different political party from the party that controls Congress. Often, the president is forced to rely on leaders from both parties to get programmes passed. Under the presidential system, Congress may refuse to pass legislation the president wants. On the other hand, the U.S. president may *veto* (reject) legislation passed by Congress—and Congress seldom overrides a veto.

In some countries, such as India or Ireland, the presi-

**A political party** works to gain or maintain control of a government. One way political parties support themselves is by raising money at fund-raising dinners, such as the one shown above.

dent is head of state but has no real political power. In other countries, such as France and the Philippines, the president has executive powers and exercises considerable authority in the political arena. Even so, a president may have to deal with a legislative assembly whose membership is balanced against support for the president's policies. Members of political parties within the legislative assembly may form shifting alliances, and so may increase or decrease support for the president's policies.

*The parliamentary system.* In such parliamentary democracies as the United Kingdom, the head of the government is the prime minister. The prime minister must be a member of Parliament and is almost always the leader of the majority party in the House of Commons. The prime minister usually chooses a Cabinet from among other leaders of the majority party who are members of Parliament.

In the United Kingdom, the prime minister and Cabinet thus have both executive and legislative authority. They are members of the legislature and responsible to it. If the prime minister's programme fails to win parliamentary support, the opposition party may demand an election. This election is called for by the government but must occur within five years of the previous election. The people will vote either to keep the present government in power or to give the opposition party the opportunity to form a new government.

**Organizing within the legislature.** Inside the Congress or Parliament, elected members of political parties organize to carry out business effectively. At the start of each new session of the legislative assembly, party members meet to elect various officers and committee members. The meetings of the assembly are presided over by a *speaker,* an officer chosen by the votes of members of the assembly. In practice, the majority party generally chooses the speaker (see **Speaker**).

Parties also have officials called *whips.* The whips keep party leaders informed about how party members feel about bills coming up for vote. The whips also try to ensure party discipline by making sure that all members attend to vote along party lines on important issues.

Within most legislative assemblies, bills are worked on by committees of members. These committees represent the balance of the different political parties in the legislature, and so are usually headed by a member of the majority party. See **House of Commons, House of Representatives, Parliament.**

**Providing opposition.** In a democratic country, the party or parties out of power have the duty of criticizing the policies of the party in power and offering alternative programmes. In France, Italy, and other countries that have many parties, the opposition parties may represent various points of view—from those favouring a monarchy to those preferring Communism. In most two-party nations, the party out of power usually provides unified opposition. Parties may combine as coalitions to form, or to challenge, a government.

**Raising funds** for election campaigns is an important activity of political parties in democratic nations. Cam-

**During an election campaign,** local party members hand out leaflets to inform voters about their party's policies. Members support their party's candidate in each constituency.

**Political candidates** speak during the period before elections at public meetings arranged by their parties.

paigns are expensive, but parties must wage them to win elections.

Most campaign expenditure goes on television and radio advertising, campaign consultants, opinion polls, printing charges, telephone bills, posters, and salaries. Some campaign funds come from the small contributions of thousands of party members and supporters. But much of the money comes from large donations by wealthy people and institutional groups such as trade unions.

**Other functions.** In democracies, each party uses newspapers, radio, television, and other means to tell people about its programme. In so doing, a party hopes to win—or stay in—office. The party in power tries to justify its programme. The opposition parties, on the other hand, point out what they consider weaknesses in the majority party's programme and offer voters an alternative one. In publicizing their views, political parties thus help keep the voters informed on important issues.

Political parties also simplify complicated issues for the voters by reducing the issues to choices between candidates for office. In order to win votes, political candidates also look for problems that have not received public attention and that affect many people. In this way, political parties help force the government to act on neglected problems.

### Party systems

The number of political parties that win a significant share of votes in major elections determines the *party system* that a country has. A country may thus have a one-party, two-party, three-party, or multiparty system.

**One-party systems** are often associated with dictatorships. Most dictatorships allow only one party—the party that controls the government. Some dictatorships permit other parties, but only as long as they create no threat to the government.

In a one-party Communist State, such as China, the Communist Party forms the government. No other party may exist. Party membership is considered a privilege and is granted only after a person meets certain standards. The party performs many more functions than political parties in democracies. For this reason, it has elaborate organization for recruiting members and leaders, developing policy, indoctrinating the people, and maintaining discipline. See **Communism** (Main features).

Communist countries and most other one-party dictatorships have elections. The elections are held chiefly to generate enthusiasm for the party. Party leaders explain what the party has done and plans to do and what it expects of the people. There are no opposition parties to criticize the government openly.

Some democracies also have a one-party system. For example, the Institutional Revolutionary Party controls Mexican politics. Since the late 1920's, it has won all state and national elections by huge majorities. The country has several smaller political parties, but, at the national level, none can compete effectively with the Institutional Revolutionary Party.

**Two-party systems** are most common in English-speaking nations. These two-party countries include the United Kingdom, which in recent times has been dominated by the Conservative and Labour parties. There are other smaller parties, such as the Liberal Democrats, but the electoral system tends to restrict their importance.

Although a nation may have a two-party system, one party may control politics in certain areas of the country. In the UK, for example, certain *constituencies* (voting districts) traditionally support the Conservative Party. Some other constituencies usually support the Labour Party. In national elections, each party considers certain constituencies "safe." A constituency which swings from one party to the other, often by a small number of votes, is called "marginal". In the UK, candidates for national office do not have to live in the constituency they hope to represent.

**Three-party systems** include that of Australia, which has three main political parties—the Australian Labor Party (ALP), the Liberal Party of Australia, and the National Party of Australia. In Parliament, the Liberal and

National Parties generally form a coalition in government or in opposition to the ALP.

**Multiparty systems** are found in many nations that have parliaments. Multiparty countries include Belgium, Denmark, France, India, Italy, Japan, and Sri Lanka.

Most multiparty nations have four or five major parties. In addition, a nation may also have many minor parties. In most cases, each party seeks a particular economic or social goal. Multiparty systems vary from country to country. But most systems consist of one or two *left-wing* parties, which hold liberal or radical views; one or two *centre* parties, which have moderate views; and one or two *right-wing* parties, which support conservative views. An example of a nation with four main political parties is Ireland. The four major parties are *Fianna Fáil* (Soldiers of Destiny), also called the Republican Party; *Fine Gael* (Gaelic People); the Labour Party; and the Progressive Democrats.

In multiparty nations, one party rarely wins enough seats in the legislature to form a government. Consequently, two or more parties join forces and form a *coalition government* to direct the nation's affairs. For example, in India the Janata, Lole Dab, and Congress (Socialist) parties combined as the People's Front to defeat the governing Congress Party in 1989. But often, the coalition parties fail to agree on policies and programmes, and so the government falls. The multiparty system thus tends to produce a less stable government than does the two-party system.

**Party membership** varies from country to country. In the United States, people are regarded as members of the party to which they consider themselves to belong. In other countries, parties maintain membership lists and charge a subscription. Members attend party conferences, to discuss and vote on party policies and programmes.

## History

The first organized political parties were formed in the 1800's in Europe and America. Earlier parties, such as the Whigs and Tories of Britain in the 1700's, were loose groupings of people with similar interests who wished to control the government. These people, mostly wealthy landowners and businessmen, competed for the monarch's favour. They had little need to campaign for election, since voting was restricted to a very few people.

As more democratic government systems developed, proper political parties were set up. However, many leaders, including George Washington, the first president of the United States, opposed their development. Nevertheless, common economic, political, and social interests brought people together to form political organizations.

Most historians accept that Sir Robert Peel formed the first Conservative government of Britain in the 1830's. For a long time in the 1800's, the Conservatives and Liberals competed for power in Britain. The Conservative Party organization was modernized by Benjamin Disraeli (see **Disraeli, Benjamin**).

By the 1920's, the Liberal Party was in decline, and the newly formed Labour Party was gaining support. The British Labour Party was set up by trade unionists and socialists who sought to create a mass-membership party with working-class support. They hoped to bring about the election of working-class members of parliament.

Labour was strong enough to form a government in the 1920's. During World War II (1939-1945), Labour shared power in a coalition with the Conservatives and Liberals. After the war, Labour won the 1945 election. Since then, Britain's political scene has been largely dominated by the Conservative and Labour parties.

Dictators have used political parties to secure and strengthen their hold on power. In the 1920's and 1930's, anti-democratic Fascist parties came to power in several European countries (see **Fascism**). At the same time, Communist parties grew in a number of countries. Following the Soviet model set up after the 1917 Russian Revolution, these Communist parties were usually rig-

**Party members** persuade voters to support their party's candidate in an election. A Labour Party member, *right*, in New Zealand promotes his party's policies at a trade union meeting.


**In 1994,** supporters of the African National Congress celebrated their party's victory in South Africa's first nonracial democratic elections.

idly organized, with a centralized leadership. Democratic parties sought to create organizations that gave party members a say in the running of the party, the choice of leader, and the party's programmes.

After World War II, political parties were formed in a number of countries seeking independence from colonial rule. Leaders of these parties became leaders of new nations such as Ghana, India, and Singapore.

Sometimes, political parties reflected old tribal, ethnic, or religious groupings. For example, in the British African colony of Rhodesia (now Zimbabwe), black nationalists belonging to the National Democratic Party split into two separate parties: the Shona-based Zimbabwe African National Union (ZANU) and the Ndebele-based Zimbabwe African People's Union (ZAPU). These parties supported guerrilla organizations to fight the white-dominated government of Rhodesia. After independence in 1980, ZANU won power in the elections and the influence of ZAPU was steadily diminished. In some developing nations, the concept of opposition parties has not been adopted as an essential feature of democratic government. Such nations have moved towards becoming one-party states.

**Related articles** in *World Book* include:

**Political parties**

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Fianna Fáil
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Left wing
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Primary election
Proportional representation
Radicalism
Right wing
Socialism

**Outline**

I. Party functions
- A. Selecting candidates
- B. Organizing the government
- C. Organizing within the legislature
- D. Providing opposition
- E. Raising funds
- F. Other functions

II. Party systems
- A. One-party systems
- B. Two-party systems
- C. Three-party systems
- D. Multiparty systems
- E. Party membership

III. History

**Political science** is the systematic study of political life. Political scientists seek answers to such questions as "What reasons justify the actions of government?" and "Whose interests are served by governments?" They study various forms of government as well as political parties, pressure groups, elections, international relations, and public administration. All these are activities of individuals and groups and involve basic human relationships. Political science deals with such fundamental values as equality, freedom, justice, and power.

Political science is closely related to economics, history, law, philosophy, and sociology. Economics deals with the control of all material resources, including goods and services, which affects the political power structure within a nation and among groups of nations. History provides much of the raw material with which the political scientist works. Law, especially public law, supplies a framework of formal ideas for the political scientist. Philosophy relates political science to the other sciences. Sociology provides understanding of the social developments that affect political life.

The study of political science has increased greatly with the growth and spread of democracy during modern times. In every democratic country, political science is essential in the processes of government. The political scientist studies these processes and the operations of government agencies and departments. The work of political scientists provides a factual basis for criticism and reform—probably the most important elements of democratic government. Political scientists also develop useful materials for the education of young people. Without that kind of training for future citizens, a democratic society could not prosper.

The field of political science is growing rapidly. Many research specialists and teachers choose careers in political science. They often participate in government programmes as advisers. They also act as consultants to legislators or other public officials.

### Fields of political science

Political science may be divided into six main fields: (1) political theory and philosophy, (2) comparative government, (3) international relations, (4) national government and politics, (5) public administration, and (6) political behaviour.

**Political theory and philosophy** are usually dealt with historically. Most political scientists believe that the history of political thought forms the basis of all political studies. They consider the reading of great books on political theory and philosophy to be essential for a broad education in politics. The writers of these works include Plato, Aristotle, Cicero, Saint Augustine, Saint Thomas Aquinas, Niccolò Machiavelli, Thomas Hobbes, Jean Jacques Rousseau, John Locke, Montesquieu, Immanuel Kant, Georg Wilhelm Friedrich Hegel, and Karl Marx. Careful attention is also given to the writings of Jeremy Bentham and John Stuart Mill.

The classic political and philosophical works help political scientists explore and understand many issues of *empirical politics* (politics based on experience). With this understanding, political scientists can establish correct generalizations based on verified facts. These generalizations deal with such subjects as how power is gained or lost and the problems of representative government.

**Comparative government.** An understanding of political reality may be achieved by comparing the political institutions and practices of two or more countries. Some scholars in comparative government specialize by studying the countries of a particular area of the world.

**International relations** include diplomacy, international law, and international organization. Since 1945, much emphasis has been placed on the study of the United Nations. During the 1960's and 1970's, specialists in international relations became increasingly interested in China and the developing nations of Africa, Central and South America, the Middle East, and Southeast Asia.

Vital forces in the modern world, including imperialism and nationalism, are important subjects of international relations. This field of political science also deals with defence policies and a wide range of problems connected with peace and war. In addition, political scientists examine the effects of economic pressures on international relations.

**National government and politics** is a field to which political scientists generally give special attention. They feel it is necessary to study their own government's development more deeply than that of other governments.

**Public administration** is actually part of comparative government and of domestic government and politics. It is separated from those fields because of the range and complications of modern administrative activities. Public administration deals with such tasks of public officials as accounting, budgets, and personnel management. Public officials often work closely with political scientists who are experts in administration. These experts study the many departments of national governments. They analyse how the organization and internal politics of government departments aid or hinder putting political decisions and programmes into effect.

**Political behaviour** is the field that explores the way people respond to certain political conditions or influences. For example, the political scientist may take note of how many voters favour a candidate who looks good on television. Behavioural studies are the most recent trend in political science. They have been influenced by developments in such behavioural sciences as anthropology, psychology, and sociology. Political scientists have developed ways to study certain key behaviour patterns in politics. Studies have been made in communications, propaganda, voting behaviour, and other activities.

### The development of political science

The ancient Greek philosopher Aristotle called political science the "master science." He considered politics the highest science because he thought all other sciences depended on it. For many years, most scientists laughed at this idea. But today, many scientists share Aristotle's opinion because they realize that a nuclear war could wipe out humanity. They are convinced that the knowledge of how to control the results of scientific work politically—in other words, how to maintain peace—is probably the most important of all human endeavours.

Aristotle and his teacher, Plato, believed that the main task of political science was to work out a model political order. This political order would establish maximum justice while remaining completely stable. Plato was primarily a philosopher of ideas. He derived his insight chiefly from *abstract speculation* (thinking about nonconcrete things). Aristotle, on the other hand, insisted on *empirical studies* (investigation based on experience) in order to construct his political theories. See **Aristotle; Plato.**

**Scholasticism** was a major philosophical movement during the late Middle Ages. Its followers, often called *scholastics,* undertook to fit the Greek tradition of political science into the religious framework of Christianity. Their main concern was to harmonize the power of government with ethics and moral laws.

The greatest scholastic was Saint Thomas Aquinas. He ranked all other political subjects below law. In one of his most important works, *Summa Theologica,* Aquinas elaborated on Aristotle's theories and adapted them to Christian purposes. Aquinas emphasized certain rights and duties of individuals in the processes of government. He also stressed that government should rule in

accordance with these rights and duties. By stating that government was limited by law, Aquinas helped lay the foundation of modern constitutionalism. See Aquinas, Saint Thomas; Scholasticism.

**Secularism.** The theories of the medieval philosophers were challenged in the 1500's and early 1600's. Niccolò Machiavelli, a famous Florentine politician, pushed aside Christian idealism in favour of realistic power politics. Machiavelli's ideas were generalized by Thomas Hobbes, an English philosopher. Hobbes claimed that a person's entire life was a "ceaseless search for power." This approach became known as secularism because it separated politics from religion. Three writers who put these ideas into legalistic form were Jean Bodin, a French jurist; Johannes Althusius, a German political scientist; and Hugo Grotius, a Dutch lawyer who was the founder of the science of international law.

**Constitutionalism** is a political system in which the powers of government are in fact limited by law or tradition. Constitutionalism developed during the mid-1600's. It was a reaction to absolutism—that is, absolute rule by one person. The reaction was especially strong in England, where it was climaxed by the Glorious Revolution of 1688 (see England [History: The Restoration]).

Several English writers influenced the basic theories of Western constitutionalism. These writers included Richard Hooker, John Milton, and James Harrington. John Locke, perhaps the most influential political writer of the time, emphasized basic human rights and believed that people should revolt against governments that violated these rights. His book *Two Treatises of Government* (1690) greatly influenced political thought in the American colonies. Locke's ideas helped shape the Declaration of Independence and the United States Constitution.

**Liberalism** developed as a political philosophy largely from the theories of Locke. Liberalism represents a willingness to change ideas, proposals, and policies to meet current problems. Locke's theories were given a broader base by Montesquieu, one of a group of French writers called the *philosophes*. Liberal theories were reinforced by the radical individualism of Jean Jacques Rousseau and the utilitarian theories of David Hume, a Scotsman, and Jeremy Bentham, an Englishman. Individualists believe that freedom of the individual is as important as the welfare of the community. Utilitarians believe that the goal of politics is "the greatest happiness of the greatest number." John Stuart Mill, a prominent English philosopher and economist, summarized most of the liberal ideas that had developed up to his time (see Mill [family]).

Three great German philosophers contributed liberal ideas that were somewhat different from classic liberalism. They were Immanuel Kant, Johann Gottlieb Fichte, and Georg Wilhelm Friedrich Hegel. The liberalism of Fichte and Hegel included ideas of socialism and nationalism. Kant's liberalism included a theory of universal peace through world organization. Kant explained his theory in a brief classic, *On Eternal Peace*, published in 1795. See Liberalism.

**Democracy and socialism.** Some of Rousseau's writings carried his political theories beyond radical individualism. In *The Social Contract* (1762), Rousseau became the theorist of democracy. His emphasis on the collective—the general will, as Rousseau described it—gave rise to socialism. Eventually, the theories about democracy became divided. Liberal, constitutional democratic ideas were followed in the United States. Socialist democratic ideas became predominant in Europe.

Socialism was further developed by Karl Marx, a German philosopher and economist. He first expressed his socialist ideas in the *Communist Manifesto* (1848), which he wrote with his colleague Friedrich Engels. Communism in the Soviet Union was based on Marxist doctrines as interpreted and modified by V. I. Lenin, who led the Russian Revolution in 1917. The rulers of China and other Communist countries still follow Marxist-Leninist principles. Marxism-Leninism is significantly different from the Marxist doctrines followed by democratic socialists in many of the countries of Western Europe. See Communism; Democracy; Socialism.

**Contemporary ideas.** Since about 1900, most political scientists have sought increasingly to strengthen the empirical basis of their work. They have been returning to Aristotle's view of basing political theories and methods on experience. As a result, much progress has been made in descriptive and analytical work, and in quantitative studies.

Today, political scientists make practical improvement and political reform their major concerns. The modern approach of using empirical methods in political science is being taken up in one country after another. Many political studies consider most nations of the world. Such global interests find expression in the International Political Science Association. About 40 national political science associations work together in this organization.

See also Government and its list of *Related articles*.

**Poliziano, Angelo.** See Italian literature (Humanism and the Renaissance).

**Polk, James Knox** (1795-1849), was president of the United States from 1845 to 1849. A Democrat, Polk was one of the most successful presidents. He carried out every item of his political programme.

Polk led the U.S.A. during the period of its greatest territorial growth. During his presidency, the U.S.A. acquired most of the area now forming nine western states, and Texas became a U.S. state. Polk successfully directed the Mexican War (1846-1848), which won much of this territory, including California (see Mexican War). He also settled a boundary dispute with the United Kingdom over the Oregon Territory. Polk reduced tariffs and re-established an independent federal treasury. Polk was born near Pineville, North Carolina, U.S.A. He was a lawyer and political leader in Tennessee.

**Polka.** See Dancing (Folk dancing; The rise of romantic dance).

**Poll of public opinion.** See Public opinion poll.

**Poll tax** is a tax levied equally on all the citizens of a community. The amount of the tax is the same for a poor person as it is for a rich one. The term *poll tax* comes from the old English word *poll*, which means *head*. Many people refer to it as a *head tax*. A poll tax is sometimes called a *capitation tax*, from the Latin word *caput*, meaning *head*. Some people object to poll taxes because they feel taxes should be based only on income and property. However, many economists favour poll

… because they believe that such taxes do not lessen … incentive to earn more money to better them… and society.

The community charge in the United Kingdom (UK) was a type of poll tax. It was paid to each local authority and the revenue was used to provide public services. The amount of the community charge was set by the local authorities. Every adult was liable to pay the *personal* community charge, unless exempt, and had to be registered for it on a special register not related to the electoral register. Exemptions were for people resident in hospitals, nursing homes and monasteries, people with severe mental disorders, prisoners, and the homeless. People on low incomes could claim a rebate and students paid only 20 per cent of the charge. Additionally, there was a *standard* community charge for people with second homes. The community charge started in 1989 in Scotland and 1990 in England and Wales. The tax proved extremely unpopular with the British public. It was replaced in 1993 by the Council Tax, a local tax based on property valuations, but with some elements of the community charge.

Poll taxes were levied in ancient tax systems. In 1380, a poll tax introduced in England was heavily criticized for its unfairness. It was a major cause of the 1381 peasants' revolt led by Wat Tyler. In the 1880's and 1890's, poll taxes were introduced in the Southern States of the U.S. as a condition of voting in the national elections. They were a cause of social unrest because many blacks and poor whites lost their votes.

**…lock.** See Pollock.

**…, Antonio Del** (143?-1498), was an Italian sculptor and painter. The ways in which he portrayed the human body in his sculpture and painting greatly influenced the work of the Renaissance artists Andrea del Verrocchio, Leonardo da Vinci, and Michelangelo.

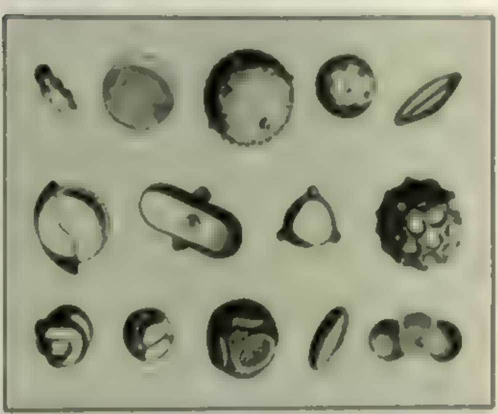
…uolo was born in Florence. About 1460, he completed three large paintings of the deeds of Hercules. These paintings have not survived, but two small versions show figures struggling furiously. He reworked the subject of *Hercules and Antaeus* in a small bronze … that is so powerful in its expressive use of anatomy that viewers feel they are participating in the action. …uolo lived in Rome from about 1483 until his death, designing and casting the bronze tombs of Popes Sixtus IV and Innocent VIII.

**Pollen** consists of tiny grains that are produced in the male organs of flowering and cone bearing plants. Seeds develop after pollen is transferred from the male part of a plant to the female part. This transfer of pollen is called pollination.

Most pollination is accomplished by birds, insects, or the wind. Most flowers pollinated by birds and insects have colourful blossoms, a pleasant odour, and sweet nectar that all attract the animals. When they come into contact with a flower, pollen clings to their bodies, and they then carry the grains to other flowers. The wind blows pollen from one flower or cone to another. Most flowers pollinated by the wind have neither bright colours nor a fragrant odour.

A flowering plant produces pollen in its *stamens*, the male parts of a flower. After pollination, seed development occurs in the female part, called the *pistil*. A cone-bearing plant produces pollen in its *male pollen cones*. Pollination occurs when the wind carries pollen from the male pollen cones to the *female seed cones*.

Many people are allergic to pollen. Large amounts of pollen in the air cause them to develop hay fever. This allergy results in headaches, red and itching eyes, a runny nose, and sneezing. Fossilized pollen grains are often preserved in sediments from lakes and bogs. By studying these grains, scientists can learn much about the plant life and climate of earlier ages.



**Pollen grains** are so small that they look like tiny specks to the unaided eye. But they have definite shapes and surface patterns depending on the kind of plant that produced them.

## Pollen grains

Pollen grains vary in shape, size, and surface features. These variations make the grains of each species of plant different. Most pollen grains are round or oblong and range from 15 micrometres to more than 200 micrometres wide. (Ten thousand micrometres equal one centimetre.) Every grain has an outer shell, which may be smooth or wrinkled, or covered with spines or knobs. This shell prevents the inner cells drying out.

Such plants as maize and wheat, which are pollinated by wind, produce huge amounts of pollen. A maize plant can produce more than 18 million grains. But some plants that are pollinated by birds and insects produce only a few thousand grains.

Most pollen grains live only several days or weeks after being released. However, the cells of date palm pollen live for as long as a year.

## Methods of pollination

There are two methods of pollination: *cross pollination* and *self pollination*. Cross pollination is the transfer of pollen from the stamens of one flower to the pistil of a flower of another plant. Self pollination occurs when pollen is transferred from the stamens of one flower to the pistil of the same flower, or to another flower on the same plant.

**Cross-pollination** is the most common method. For seeds to develop, cross pollination must occur between flowers of the same or closely related species.

Honey bees carry out more cross pollination than any other kind of insect. They make honey from nectar and use pollen for food. Honey bees collect pollen in small

cavities on their hind legs and carry it back to the hive. However, some pollen clings to their bodies and is carried to other flowers. Other insects that carry pollen include ants, beetles, butterflies, and moths.

Among birds, hummingbirds are the most important pollinators. They insert their long, thin beak into flowers and drink the nectar. Pollen sticks to the beak and is carried to the pistils of other flowers.

The wind pollinates many plants, including birches, maize, grasses, nettles, and oaks. It may carry pollen grains 150 kilometres or farther from the plant.

Botanists have used artificial cross-pollination to create new varieties of maize, cotton, wheat, and other plants. They use special brushes to transfer pollen from one plant to another.

**Self-pollination.** Many plants, including beans, cotton, oats, peas, and wheat, normally pollinate themselves. Certain cross-pollinating plants, such as pansies and some violets, can also self-pollinate.

The growth process and the structure of some flowers prevent self-pollination. In plants called crane's-bills and spiderworts, for example, the stamens ripen earlier than the pistils. Therefore, the pollen is shed from the stamens before the pistils of the same plant become ripe. Willow trees and other species have *imperfect flowers.* In such species, each plant bears flowers with either stamens or pistils, but not both.

### Fertilization

All flowering and cone-bearing plants produce seeds through *fertilization.* In fertilization, which occurs after pollination, a male sperm cell unites with a female egg cell.

In flowering plants, the egg cells develop in the *ovary,* the base of the pistil. The sperm cells are produced by the pollen grains. After pollination, a pollen grain swells as it absorbs water, sugar, and other materials from the *stigma,* the top of the pistil. The pollen then *germinates*—that is, it grows a tube downward to the *ovary,* where one or more *ovules* are located. The ovules are the structures that contain the egg cells. After the pollen tube reaches an ovule, it releases two sperm. One sperm fertilizes an egg cell. In flowering plants, the second sperm fertilizes two female structures called the *polar nuclei.* The union of the second sperm with the polar nuclei produces the *endosperm,* the food-storage tissue of the new seed. Only flowering plants form seeds through such *double fertilization.*

In cone-bearing plants, the sperm and egg cells develop in the male cones and female cones. After pollination, one of the two sperm fertilizes an egg. The other sperm disintegrates.

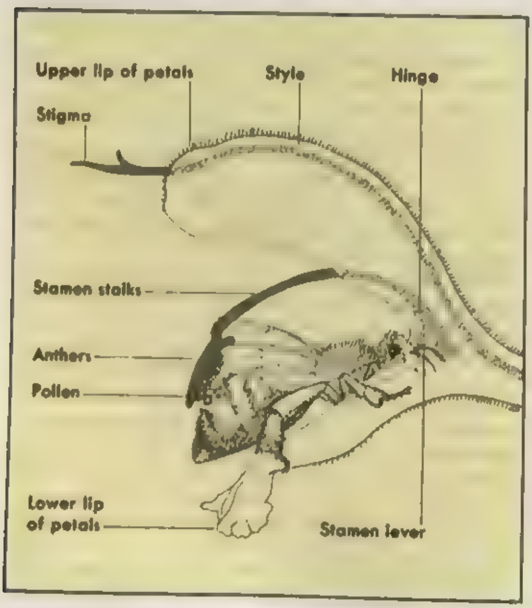
**Related articles** in *World Book* include:

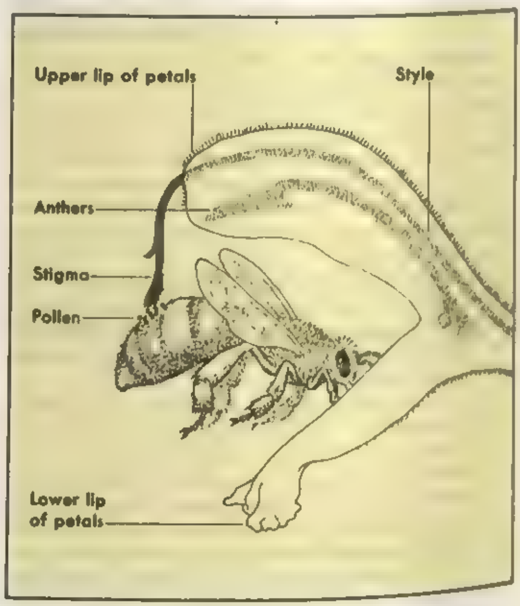
Bee
Breeding (Plant breeding)
Bumble bee
Flower (Role of flowers in reproduction; pictures)
Insect (picture: Pollination)
Maize (How the plant reproduces)
Plant (Sexual reproduction)
Tree (picture: How most trees reproduce)

**Pollinosis.** See Hay fever.

**Pollock,** also spelled *pollack,* is a food fish related to the cod. It is found off rocky coasts in the North Atlantic Ocean. The pollock grows to between 60 and 105 centimetres in length. It has a dark greenish-brown back, is lighter underneath, and has a projecting lower jaw.

Pollocks travel in schools. They always seem to be hungry and often prey on smaller fish. Pollocks are caught along the Atlantic coast of Europe. They are also




**Pollination of the European sage** is a complicated operation. When a bee enters a young flower, *left,* the insect's head hits the stamen lever. This hinged lever causes the anthers to swing downward, depositing pollen on the bee's back. If the bee goes to an older flower, *right,* pollination will occur. In the older flower, the stigma droops down to receive pollen. As the bee enters the flower, the pollen is brushed off its back and sticks to the stigma.

caught off the east coast of North America in seine nets.

**Scientific classification.** Pollocks belong to the codfish family Gadidae. The European pollock is *Pollachius pollachius;* the North American pollock is *P. virens.*

**Pollock, Jackson** (1912-1956), was an American artist who had an important influence on modern painting as a leading figure in the abstract expressionist movement. He devised a painting technique in which he dripped paint onto his huge canvases to form sweeping, rhythmic patterns that seem to weave across the surface.

Pollock painted with his canvas on the floor. He said, "I feel nearer, more a part of the painting, since this way I can walk around it, work from the four sides, and literally be *in* the painting." The attitude that the working artist is *in* the painting is generally considered characteristic of abstract expressionism.

Pollock was born in Cody, Wyoming, U.S.A. From 1929 to 1931, he studied with Thomas Hart Benton at the Art Students League in New York City. He worked in the Federal Art Project from 1938 to 1942. Pollock painted in an expressionistic symbolic style before moving to pure abstraction in the late 1940's. In his last works, he returned to certain figurative references from his earlier works. He combined them with the loose forms developed in his technique of pouring, dripping, and working with sticks rather than with brushes.

**Pollution.** See Environmental pollution.

**Polly Woodside** was the last sailing ship to be operated in Australian waters. The ship was built in Belfast, Northern Ireland, in 1885. It was constructed of steel sheets riveted to a wrought-iron frame and had square rigging. It displaced 661 metric tons of water, and it could carry up to 1,122 metric tons of cargo. The ship was named after its owner, W. J. Woodside.

During its early years of service, the *Polly Woodside* carried coal, nitrates, and grain. In 1904, it was sold to A. H. Turnbull and Company of New Zealand. It was renamed *Rona* and used to carry cargo between New Zealand and Australia. In 1921, it was stripped for use as a coal lighter. It operated in this capacity into the 1960's.

In 1968, the ship was donated to the National Trust of Australia. It was restored during the early 1980's.

**Polo** is a ball game played on horseback on an outdoor or indoor field. In the game, two teams of four players each try to drive the ball through their opponents' goal posts.

## Outdoor polo

**The field and equipment.** A regulation polo field is 300 yards (274 metres) long and 200 yards (183 metres) wide. The field is only 160 yards (146 metres) wide if the sidelines are boarded. The sideboards are 11 inches (28 centimetres) high. The goal posts are made of light material so that they will break easily if a horse runs into them. The posts are spaced 24 feet (7.3 metres) apart at opposite ends of the field.

Polo players use plastic or wooden balls that are 3 to 3½ inches (7.6 to 8.9 centimetres) in diameter. The balls weigh about 3½ to 4½ ounces (100 to 130 grams). The players carry cane or rattan mallets about 48 to 54 inches (122 to 138 centimetres) long. At one end of the mallet is a horizontal piece of hardwood, and at the other end, a lightweight strap made of *web* (a strong cloth material). The strap fastens to the thumb. A player's

Leo de Wys

**A polo match** is an contest between two teams of expert horsemen. Each team attempts to score goals by hitting a ball through its opponents' goal posts with long-handled mallets.

equipment usually consists of boots, white breeches, knee guards, whip, spurs, mallet, helmet, and a jersey.

**The horses.** Polo horses, which are called *polo ponies,* are not of any special breed or size. Thoroughbreds and three-quarter thoroughbreds are generally considered the most acceptable.

It takes six months to a year to train a polo pony. It must be able to stop quickly, and to turn, twist, and resume stride with little loss of speed. Most difficult of all, the horse must have the courage to bump into another horse upon the command of its rider. The horse's equipment consists of saddle, bridle, bit, and leg boots or bandages.

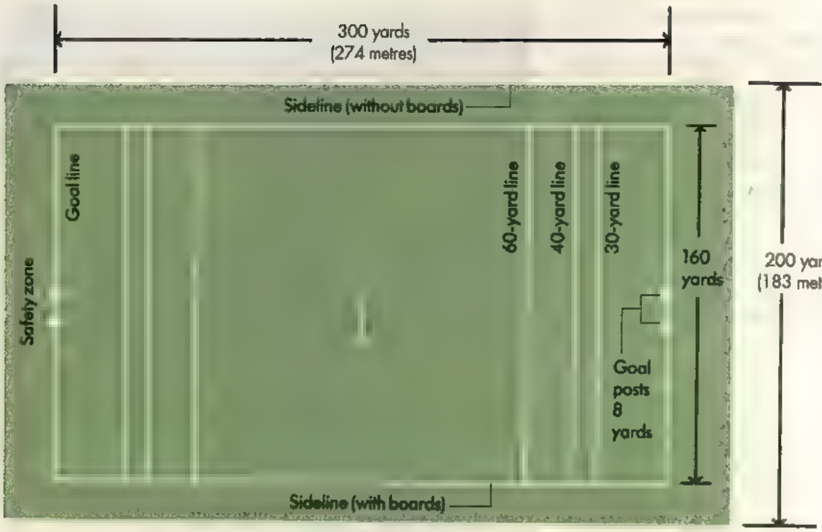
**The game.** At the start, each team is stationed in the centre of the field to defend its own goal. The first two riders play *forward* (attack), while the third and fourth play *back* (defence).

Tournament rules dictate whether there are four or six *chukkers* (periods). Each chukker is 7 minutes long. Four-minute intervals are allowed between chukkers for the players to change horses. The half-time intermission is ten minutes.

Games are played on the *handicap basis,* except for the U.S. Open tournament. Polo players have handicaps ranging from −2 to 10. The best players have the highest handicaps. The handicaps of each team's members are added to make sure the team's total handicap does not exceed the limit set for the tournament. If it does exceed the limit, the team cannot play in the tournament. On the handicap basis, the total team handicaps may count in the scoring. For example, if team *A* has a handicap of 20 and team *B* of 17, the game starts with a score of 3-0 in favour of team *B*.

## Other kinds of polo

**Arena polo,** also called indoor polo, is played on indoor fields of sand, clay, or earth. Each team has three players. The rules are similar for both outdoor and arena polo except for the size of the field, the type of ball used, and the length of the game. The size of the field depends on the size of the arena. Major indoor polo arenas measure 100 yards (91 metres) long and 50 yards




**An outdoor polo field** is 300 yards (274 metres) long and 200 yards (183 metres) wide. However, if the sidelines are boarded, then the field is only 160 yards (146 metres) wide.

(46 metres) wide. They have goals 10 feet (3 metres) wide and 15 feet (4.6 metres high), marked out on opposite ends of the field. The game has four 7½-minute periods. The ball used is inflated and is 12½ to 15 inches (32 to 38 centimetres) in circumference.

**Indoor-outdoor polo** has won increased popularity in recent years. It is played outdoors, but the players use the same rules that they do in arena polo. The field is 100 yards (91 metres) long and 50 yards (46 metres) wide, and is enclosed by a board fence 4 to 4½ feet (1.2 to 1.4 metres) high. The indoor-outdoor version of polo is popular wherever there is warm weather and a dry climate. Fewer horses are needed for this type of polo than for outdoor polo.

### History

Polo may have originated in Persia (now Iran) about 4,000 years ago. The modern game had its beginning in 1862 at Punjab, India, when a group of British officers copied the sport from some tribal horsemen. The game was introduced into England in 1869.

In Egypt, India, and England, polo was played as an outdoor sport. But the first polo game in America was played indoors, in New York City in 1876. Polo remained an indoor sport in the United States until 1880, when it became equally popular as an outdoor game. Teams from England and the United States played the first international polo series at Newport, Rhode Island, U.S.A. in 1886. Tommy Hitchcock, Jr., and Cecil Smith of the U.S.A., and Gonzalo Pieres of Argentina, are considered to be three of the greatest polo players of all time.

**Polo, Marco** (1254-1324?), an Italian trader and traveller, became famous for his travels in central Asia and China. He wrote a book that gave Europeans some of their earliest information about China.

**Early life.** Marco Polo was born in Venice. His father, Nicolò Polo, was a merchant. Nicolò and his brother, Maffeo Polo, had left on a trading mission shortly before Marco's birth. Marco's mother died when he was a young boy, and an aunt and uncle raised him. They trained Marco to be a merchant. In addition to reading, writing, and arithmetic, Marco learned about using foreign money, judging products, and handling cargo ships.

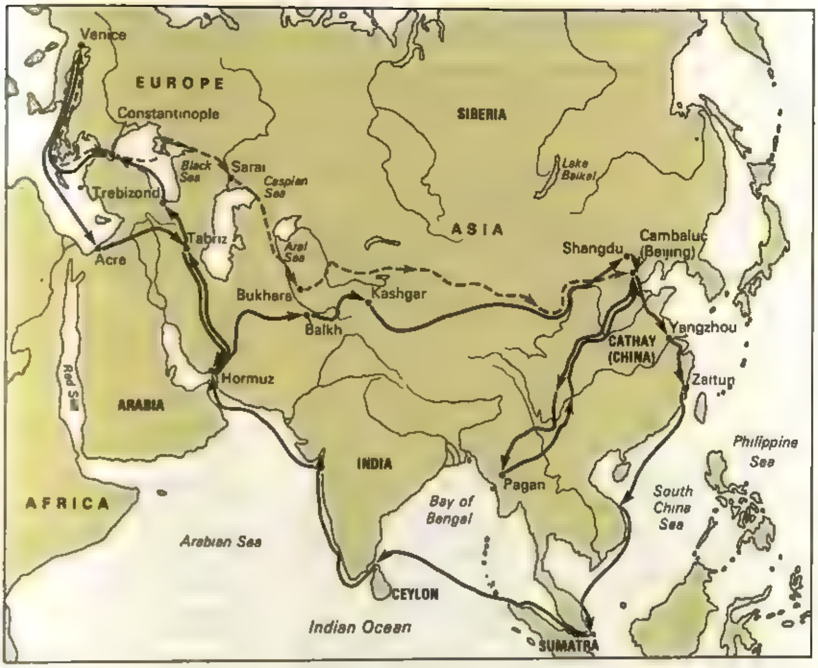
Nicolò and Maffeo Polo returned to Venice in 1269. On their travels, the brothers had been to eastern Asia and had met the Mongol ruler Kublai Khan in China. The Khan had invited them to visit China again, and so they prepared for another expedition—one that would include Marco.

**Journey to China.** In 1271, Marco Polo—then 17 years old—and his father and uncle sailed from Venice to Acre (now Akko), a port in Palestine. From there, they rode camels to the Persian port of Hormuz, which is now in Iran. The Polos wanted to sail to China from Hormuz, but the ships available there did not seem seaworthy. The travellers continued by camel across the deserts and mountains of Asia. More than three years after leaving Venice, they reached Kublai Khan's summer palace in Shangdu (also spelled Shang-tu), near what is now Kalgan. The Khan gave the Polos a hearty welcome.

Kublai Khan valued the experience and knowledge of his guests. Marco knew four languages, and the Khan sent him on many official tours of the kingdom. These tours took Marco to China's southern and eastern provinces and as far south as Burma. Marco served as a government official in the Chinese city of Yangzhou (also spelled Yang-chou) for three years.

As time passed, the Polos began to worry about returning home safely. Kublai Khan did not want the Polos to leave China, but they believed that if Kublai Khan were to die before they left China, his enemies might capture them. Finally, in 1292, their chance came. The Khan's great-nephew, the Mongol ruler of Persia, had sent representatives to China to bring back a bride whom the Khan had selected for him. The representatives asked the Polos to accompany them on their return to Persia. Kublai Khan reluctantly agreed. That same year, the Polos and a fleet of 14 junks sailed from Zaitun (now Quanzhou, also spelled Ch'üan-chou), a port in southern China.

The fleet sailed to what is now Singapore. From there, it travelled north of Sumatra and then around the southern tip of India. The Polos crossed the Arabian Sea and




**The travels of Marco Polo**

Marco Polo's father and uncle travelled from Venice to Asia in the mid-1200's. Their route is shown on the map as a dashed line. The Polos, this time accompanied by Marco, set out again for Cathay (as China was then called) in 1271 and reached Shangdu in 1274. Marco Polo's travels took him as far as Pagan in what is now Burma. The three Polos stayed in Cathay until 1292 and returned to Venice in 1295. Marco's route is shown as a solid line on the map.

the Gulf of Oman to Hormuz. There, they left the wedding party and travelled overland to the Turkish port of Trebizond (now Trabzon) on the Black Sea. They sailed to Constantinople (now Istanbul) and from there to Venice, arriving in 1295. Their journey to China and back probably totalled about 24,000 kilometres. The men had been gone for 24 years.

**Later life.** The Polos returned from China with many riches. Kublai Khan had given them ivory, jade, jewels, porcelain, silk, and other treasures. When they arrived in Venice, the city was at war with Genoa, its long-time rival. In 1296, the Genoese captured and jailed Marco Polo. Historians do not know the details of his capture. In prison, Polo decided to write about his travels. Aided by his notes, he dictated the story to a popular writer, Rustichello of Pisa. Rustichello translated it into Old French, the literary language of Italy at the time. The book was completed in 1298.

In his book, called *Description of the World,* Polo told about Kublai Khan's prosperous, advanced empire. He described the Khan's postal system, which consisted of a network of courier stations throughout the kingdom. Riders on horseback relayed messages from one station to another.

Polo commented on many Chinese customs, such as the mining and use of coal as fuel. Coal had not yet been used in Europe. Polo called coal *black stones.* He also marvelled at the Chinese use of paper money, which bore the seal of the emperor. At that time, Europeans traded with heavy coins, which were made of copper, gold, or lead.

Printing had not yet been invented in Europe, and so scholars copied Polo's book by hand. *Description of the World* was widely read in Europe. Historians believe it may have influenced many explorers. The book influenced Christopher Columbus's estimate of the distance between Spain and Asia.

*Description of the World* also stimulated European interest in Asia and helped bring to Europe such Chinese inventions as the compass, papermaking, and printing. Genoa and Venice made peace in 1299. Polo was freed and returned to trading in Venice.

See also **Exploration** (picture); **Kublai Khan.**

**Polo, Water.** See **Water polo.**

**Polocrosse** is an outdoor sport played on horseback. Each team has six players, but only half are on the field at any one time. Players pick up or catch the ball in a net attached to a long polo stick shaft. They pass it from one to the other and try to score goals by throwing the ball through goal posts.

Polocrosse was invented in Australia by Brigadier Edward Hirst as a variation of a similar sport played indoors in England. Brigadier Hirst and his wife first played the English version in 1938. In 1939, they formed the Ingleburn Horse and Pony Club, which sponsored polocrosse in Australia.

**Polonaise** is a dignified national dance of Poland which developed from the promenade.

**Polonium** is a chemical element with symbol Po. It is a rare, radioactive metallic element. The French physicists Marie and Pierre Curie discovered it in 1898. They named it in honour of Poland, the country of Marie Curie's birth. Polonium occurs naturally in the uranium ore pitchblende. But most polonium is made artificially by bombarding bismuth, a metal, with neutrons.

The atomic number of polonium is 84. It melts at 254 °C and boils at 962 °C. Polonium has 27 known isotopes—more than any other element. All of them are radioactive. Its most stable isotope has a mass number of 209 and a half-life of 103 years. During radioactive decay, polonium changes into lead by giving off alpha particles.

**Poltava, Battle of.** See **Army** (table: Famous land battles); **Charles** (XII).

**Polyandry.** See **Polygamy.**

**Polyanthus** is the name of several hybrid primroses (see **Hybrid**). They began in the United Kingdom and Europe, as a cross between a primrose and a cowslip. Polyanthuses are now widespread in gardens. They flower in early spring.

**Scientific classification.** Polyanthuses belong to the family Primulaceae. They include *Primula polyantha.*

**Polychlorinated biphenyl (PCB)** is any of a group of synthetic compounds formed by substituting atoms of chlorine (chemical symbol, Cl) for atoms of hydrogen (H) in a compound called *biphenyl* ($C_6H_5C_6H_5$). A PCB molecule may have from 1 to 10 chlorine atoms.

PCB's once were widely used in many countries in manufactured products. In 1979, however, the United States government prohibited the production of PCB's because of concerns about the effects of PCB's on people. Scientific studies had shown that high concentrations of PCB's may cause birth defects, cancer, liver damage, and nerve disorders.

Manufacturers used PCB's in such products as paints and adhesives and in fluids for lubricating industrial machinery. PCB's also were used as insulators in transformers, capacitors, and other electrical equipment.

**Polycythemia.** See **Bloodletting.**

**Polyester** is any of a group of widely used plastics materials. The most important polyester, *polyethylene terephthalate* (PET), can be spun into fibre, *extruded* (pushed through an opening) to make film, or combined with other materials and moulded into plastic parts. PET is a *thermoplastic*—that is, it softens and melts at high temperatures (see **Plastics** [Types of plastics]).

Polyesters are synthetic *polymers.* A polymer is a long, chainlike molecule. The "links" are repeating patterns of simple groups of atoms called *monomers.* The key feature of the PET repeating unit is two ester groups, each made up of one carbon atom and two oxygen atoms.

PET fibre is one of the most widely produced synthetic fibres. It appears in such products as tyre cords and clothing. It is strong and flexible, and it resists wrinkling and mildew. Much PET fibre is sold under the name *Dacron,* a registered trademark of the DuPont Company.

Uses of PET film include magnetic tapes and shrink wrap. PET is also used to make plastic soft drink bottles, which, like PET film, are clear and tough, and resist water and chemicals.

Other important polyesters are the *unsaturated polyesters.* The monomers in these materials contain *unsaturated acids,* which are hydrocarbon acids with two carbon atoms joined by double bond (see **Hydrogenation**). Manufacturers use these polymers to make *thermosetting plastics,* which do not soften when heated. Polyester "thermosets" can be combined with *fibreglass* (glass threads) to make a strong rigid material used for car body parts, boats, and bowling balls.

Polyester thermoplastics are easy to recycle. The thermosetting materials are difficult to recycle, but can be ground into powders and used as fillers.

Researchers discovered the chemistry of polyesters in the 1930's. In the 1940's, the aircraft industry began to use unsaturated polyesters. In the 1950's, PET fibre became a major product.

**Polyethylene** is a major *synthetic polymer,* an essential ingredient of plastics. Polyethylene plastic products include plastic bags and containers for milk and oil. About a third of all synthetic polymers produced are polyethylenes.

There are three main types of polyethylene: high density polyethylene (HDPE), low density polyethylene (LDPE), and linear low density polyethylene (LLDPE). HDPE is the toughest and most rigid type. Manufacturers form it into such products as bottles and jugs. LDPE and LLDPE are relatively soft and flexible. Manufacturers produce them as thin films. One use of LDPE is as bread bags. Rubbish bags are made of LLDPE, which is stronger than LDPE.

A polymer is a long, chainlike molecule. The "links" are repeating patterns of simple groups of atoms called *monomers.* Polyethylene is made from *ethylene* monomers, each consisting of two carbon atoms and four hydrogen atoms. The chemical formula of polyethylene is $(C_2H_4)_n$, where *n* is the number of monomers.

Manufacturers make polyethylene by mixing a solution of ethylene gas with a *catalyst,* a substance that speeds a chemical reaction without being used up by the reaction. Many polyethylene plastics contain special ingredients, such as colourings and a substance that prevents film from sticking to itself. Polyethylene melts at temperatures of 110 to 150 °C. It can be melted and reformed again and again, so it is easy to recycle.

Imperial Chemical Industries (ICI) of the United Kingdom first produced polyethylene in 1939. It was expensive to make, so little was produced until the 1950's, when less expensive manufacturing techniques were developed.

See also **Plastics** (Diagram: How plastic resins are made); **Polymer.**

**Polygamy** can refer either to a system in which a man has more than one wife at a time, or, less commonly, to a system in which a woman has more than one husband at a time. The word *polygamy* comes from two Greek words meaning *many marriages.* Scholars use the term *polygyny* for the taking of more than one wife, and *polyandry* for the taking of more than one husband.

Polygyny is much more common than polyandry. Many peoples have practised polygyny, and some still do, especially in Asia and Africa. The Muslim religion allows a man to have as many as four wives, and the Hindu religion sets no limit on the number of wives a man may have. When a man has more than one wife at the same time, each usually has her own house. The time the husband spends with each wife is usually strictly prescribed. The taking of many wives was once customary in China and Turkey, but those countries now have laws against the practice.

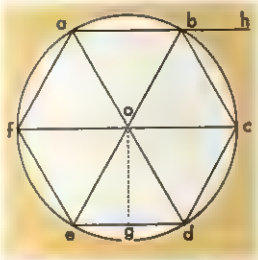
The taking of more than one husband was permitted among the Todas of India and the Inuit. Some groups in Tibet still practise it.

See also **Marriage; Mormons.**

**Polygon** is a plane figure bounded by line segments, called *sides.* The sum of the lengths of the sides is the *perimeter.* The angles formed by the sides are the *angles* of the polygon, and the meeting points of the sides are the *vertices* of the polygon. A polygon with three sides is a triangle; with four sides, a quadrilateral; with five sides, a pentagon; with six, a hexagon; with seven, a

heptagon; with eight, an octagon; with nine, a nonagon; with ten, a decagon; with eleven, a hendecagon; and with twelve, a dodecagon.

If all the sides are equal, the polygon is *equilateral.* The polygon is *equiangular* if all the angles are equal. A polygon is *convex* if no side, when extended, enters the polygon.




The angles within the polygon are called the *interior* angles. If the sides are extended, they form other angles outside the polygon that are called the *exterior* angles. In the figure, the angle *abc* is an interior angle, and the angle *hbc* is an exterior angle.

The sum of the interior angles of a triangle is 180°, or two right angles. The sum of the interior angles of a quadrilateral is 360°, or four right angles. *The sum of the interior angles of any convex polygon is the number of sides minus 2, times 180°.* Let $n$ stand for the number of sides of any polygon, and $s$ for the sum of its interior angles. Then

$$s=(n-2)\,180^\circ$$

*The sum of the exterior angles of a polygon, taking one at each vertex, is four right angles, or 360°.*

A regular polygon is both equilateral and equiangular. A regular polygon may be divided into congruent isosceles triangles. The area of each triangle is the product of its base and half its altitude. In the figure, the area of triangle *eod* is equal to

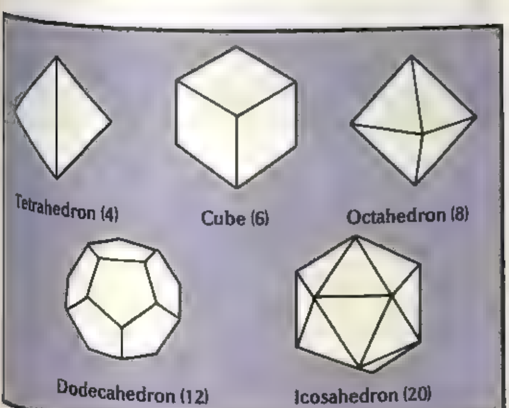
$$\frac{ed \times og}{2}$$

*The area of the polygon equals the number of triangles times the area of each triangle.*

**Polygraph.** See **Lie detector.**

**Polygyny.** See **Polygamy.**

**Polyhedron** is a solid figure bounded by four or more flat surfaces called *faces.* Each face of a polyhedron is a polygon. The sides of the polygons form the edges of the polyhedron. The points at which the edges meet are called *vertices.* Examples of polyhedrons include cubes and pyramids.




**Polyhedrons** are solid figures with four or more flat surfaces called *faces.* The five regular polyhedrons, with their number of identical faces, are shown above.

A polyhedron is *convex* if it lies entirely on one side of each of the planes determined by the faces. In convex polyhedrons, the number of vertices, minus the number of edges, plus the number of faces, always equals two.

A *regular polyhedron,* or *Platonic solid,* is a convex polyhedron in which each face is a *regular polygon* and is identical to all the other faces. A regular polygon has equal sides and equal angles. The five regular polyhedrons are tetrahedrons (4 faces), cubes (6 faces), octahedrons (8 faces), dodecahedrons (12 faces), and icosahedrons (20 faces).

**Polymer** is a large, long, chainlike molecule formed by the chemical linking of many smaller molecules. The small molecular building units are called *monomers.* Monomers are joined into chains by a process of repeated linking known as *polymerization.* A polymer may consist of thousands of monomers. Some polymers occur naturally. Others are synthetic.

Many common and useful substances are polymers. For example, starch and wool are naturally occurring polymers. Starch is formed by plants from a simple sugar called *glucose,* and wool is a variety of protein. Nylon and *polyethylene,* a tough plastic material, are synthetic polymers. Rubber, another polymer, occurs naturally and is also produced synthetically.

A chain molecule has a definite length, but, like a piece of string, it can assume a variety of shapes. This combination of molecular length and flexibility gives polymers many useful and unique properties. For example, rubber and many other polymers can be stretched to several times their normal length without breaking. The chains simply straighten into more extended shapes. Because of the large size of the molecules, polymers do not dissolve easily. They also have high *viscosity* (resistance to flowing).

See also **Monomer; Polymerization; Viscosity.**

**Polymerization** is a chemical process important in the production of plastics, artificial fibres, synthetic rubber, and paints. In this process, many small molecules called *monomers* combine to build much larger molecules called *polymers.* If only one kind of monomer is used, the process is called *homopolymerization.* If more than one kind of monomer is used, it is called *copolymerization.* The homopolymerization of the gas vinyl chloride produces polyvinyl chloride, a solid plastic commonly called vinyl (see **Polyvinyl chloride**). The copolymerization of vinyl chloride with vinylidene chloride forms the plastic used in food wrapping.

Chemists also classify polymerization processes by the chemical reactions that occur. In *addition polymerization,* entire monomer molecules bond together to form the growing polymer chain. In *condensation polymerization,* small pieces of the monomers split off, usually as water molecules, as the polymer forms.

See also **Monomer; Polymer; Petroleum** (Refining petroleum [Conversion]).

**Polymorphism** is the occurrence of three or more distinct types of adults in a species. *Polymorphism* means *many forms.* For example, there are three types of adult honey bees—queen, worker, and drone. Polymorphism is common among insects, jellyfish, bacteria, moulds, and protozoans. Breeds and varieties of domes-

ticated animals and plants, as well as sexual differences, are not examples of polymorphism.

**Polynesia.** See **Pacific Islands.**

**Polyp.** See **Cnidarian.**

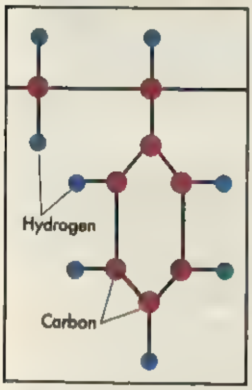
**Polyp,** a growth. See **Hay fever.**

**Polyphony.** See **Counterpoint.**

**Polystyrene** is a glasslike, lightweight plastics material used in a variety of goods. Products made of polystyrene include food packaging, insulation, housewares, and car parts.

Polystyrene is a synthetic *polymer.* A polymer is a long, chainlike molecule. The "links" are repeating patterns of simple groups of atoms called *monomers.* Polystyrene is made from styrene monomers, each consisting of eight carbon atoms and eight hydrogen atoms. The chemical formula of polystyrene is $(C_8H_8)_n$, where *n* is the number of monomers. Polystyrene is a *thermoplastic*—that is, it softens and melts at high temperatures (see **Plastics** [Types of plastics]).

Dow Chemical Company




**Polystyrene** is a synthetic *polymer,* a long, chainlike molecule made up of repeating "links" called *monomers.* A polystyrene monomer, *left,* consists of eight carbon atoms and eight hydrogen atoms. Polystyrene is fairly strong, easy to work, and inexpensive. Products made of polystyrene, *above,* include disposable cups, utensils, and food containers.

Polystyrene is fairly strong, easy to work, and inexpensive. A common way to make polystyrene is to heat styrene monomer to about 180 °C. Manufacturers produce polystyrene plastics by adding fillers, colourings, and *plasticizers* (chemicals that help soften the material) to the polymer.

A number of methods are used to make products of the plastic. *Extrusion* (pushing melted plastic through an opening) makes a film used in wall coverings. A combination of extrusion and *thermoforming* (using a vacuum to draw hot plastic sheets into a mould) produces food containers and refrigerator parts. *Injection moulding* (forcing melted plastic into a mould) creates motor vehicle parts and panels for cabinets. *Blow moulding* (forcing air and plastic into a mould) produces *polystyrene foam,* a lightweight material containing tiny bubbles of air. This material is used in ice chests, disposable cups, packaging material, and building insulation.

Polystyrene plastics are difficult to break down into their basic ingredients for recycling. Instead, recyclers grind them into powders that are used as fillers.

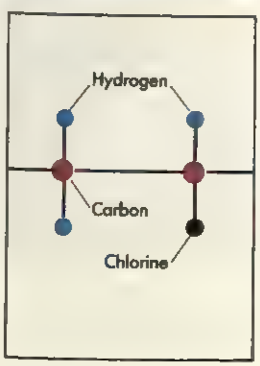
**Polytheism** is the idea that the sacred appears in many gods rather than in one God. The belief in one God is called *monotheism.* Hinduism, for example, is a polytheistic religion. There are three main gods in Hinduism and traditionally 33 million other deities as well. But most Hindus accept the idea that behind them all lies a single spiritual entity, often called *Brahman.* The belief that there is a single high God beyond the gods is also found in many tribal religions. Thus, the line between monotheistic religions and polytheistic religions is not absolute.

See also **God; Hinduism; Pantheism; Indian, American** (Religion); **Religion** (Belief in a deity).

**Polyvinyl chloride (PVC)** is a strong, durable plastics material. It mixes easily with lubricants, fillers, and colourings to make plastics with many different properties. There are two basic types of PVC plastics—rigid and flexible. Products made of rigid PVC plastic include bottles, pipes, siding, and window sashes. Flexible PVC plastic products include rainwear, shower curtains, garden hoses, and electrical insulation.

PVC is a synthetic *polymer.* A polymer is a long, chainlike molecule. The "links" are repeating patterns of

Geon Company




**Polyvinyl chloride (PVC)** is a synthetic *polymer,* a long, chainlike molecule made up of repeating "links" called monomers. A PVC monomer, *left,* consists of two carbon atoms, three hydrogen atoms, and one chlorine atom. PVC is a strong, durable material. Products made with PVC, *above,* include bottles, pipes, motor vehicle parts, and plumbing fixtures.

simple groups of atoms called *monomers.* PVC is made from vinyl chloride monomers, each consisting of two carbon atoms, three hydrogen atoms, and one chlorine atom. The chemical formula of polyvinyl chloride is $(C_2H_3Cl)_n$, where *n* is the number of monomers. PVC is a thermoplastic—that is, it softens and melts at high temperatures (see **Plastics** (Types of plastics)).

The most common method of making PVC is *suspension polymerization.* In this process, vinyl chloride monomer—a gas—is fed into water under pressure. There, the monomers link up to form the polymer.

Manufacturers make PVC plastic products by *extrusion* (pushing melted plastic through an opening), *injection moulding* (forcing it into a mould), and *calendering* (pressing it between rollers to form sheets).

Vinyl chloride can also form many *copolymers,* polymers made up of more than one monomer. The most important of these contains vinyl chloride and vinyl acetate. This copolymer is used for floor tiles.

Because PVC plastics contain many ingredients, they are difficult to recycle. However, recyclers commonly grind them into powders that are used as fillers.

**Pomare, Sir Maui** (1876-1930), was a Maori leader. In 1900, he became the first native New Zealand health officer. In 1912, he became independent member for the Western Maori electorate in the New Zealand Parliament. He was minister of health, but declined to stand as a candidate for the position of prime minister in 1925. Pomare was born at Pahau Pa, near New Plymouth, and studied in the United States. He worked with the historian James Cowan on a volume of *The Legends of the Maori.*

**Pome.** See **Fruit** (Simple fruits; picture).

**Pomegranate** is the fruit of a plant raised in warm climates. The plant grows wild in western Asia and northwestern India. It also is grown commercially in countries bordering the Mediterranean Sea and in central California, U.S.A. The pomegranate plant is bushlike when wild, but under cultivation it is trained to grow as a small tree. It reaches a height of between 4.5 and 6 metres and bears slender branches. Scarlet flowers grow at the ends of the branches.

The fruit is about the size and shape of a large orange and has a hard rind. It has a deep gold-red colour. The fruit contains many seeds. Each seed is inside a layer of crimson pulp which has a pleasant, refreshing taste. The pulp is used to make cooling drinks.

The pomegranate was familiar to the Hebrews in Biblical times. A picture of the fruit appeared on the pillars of Solomon's Temple. In classical mythology, Persephone was forced to spend one-third of each year in Hades' underworld kingdom because she had eaten pomegranate seeds while living with Hades (see **Persephone**).

**Scientific classification.** Pomegranate plants make up the pomegranate family, Punicaceae. The cultivated pomegranate is *Punica granatum.*

**Pomegranate fruit** has a hard rind. The fruit contains many seeds. The crimson pulp is used to make drinks.

**Pomerania** was a former Prussian province in an area that is now divided between Germany and Poland. Its German name was *Pommern.* The Oder River divided the province into two parts, *Hither Pomerania* to the west and *Farther Pomerania* to the east. Most of the land formerly occupied by Pomerania is a lowland with thousands of lakes south of the Baltic Sea. Throughout most of its history, Pomerania was largely an agricultural area. Stettin, now Szczecin, was the capital of the province.

Germanic peoples had settled in Pomerania by about A.D. 100. During the 500's and 600's, Slavs occupied the area. However, beginning in the 900's, German migrants and missionaries returned and in time regained control. Most of Farther Pomerania became part of the Prussian province of Brandenburg after the Peace of Westphalia in 1648, and the rest of the region went to Sweden. By 1815, Prussia controlled all of Pomerania. After World War II (1939-1945), western Pomerania became part of East Germany, and most of eastern Pomerania was absorbed into Poland.

**Pomeranian** is the name of a breed of small dog. The Pomeranian weighs from about 1.8 to 5 kilograms, and has a sharp-nosed foxlike face, and small pointed ears. It may be almost any colour from black to white, or even orange. It has a soft, fluffy undercoat and a long, thick topcoat with a frill around its neck. Its tail is also thickly covered with hair, and curls up over its back. The dog has a sharp bark. Pomeranians are one of the Spit breeds, and are related to dogs that originally came from the Arctic Circle. However, they first became well known in Pomerania, a former Prussian province in northern Germany.

See also **Dog** (picture: Toy dogs).

**Pomology.** See **Fruit** (Growing fruit).

**Pompadour, Marquise de** (1721-1764), was a mistress of King Louis XV of France. Madame de Pompadour played an important part in the politics of Louis' reign. She probably was responsible for the alliance between France and Austria in the Seven Years' War in 1756. Mad-

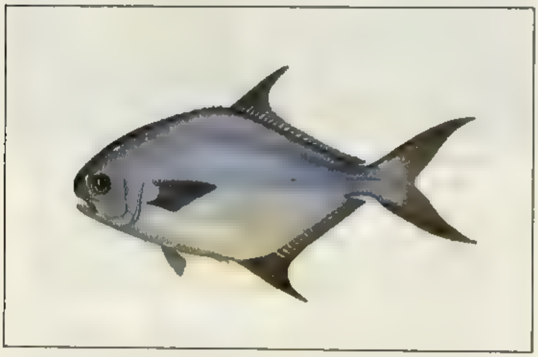
**Madame de Pompadour**

ame de Pompadour kept her influence over the king long after his love for her had cooled. She entertained him and held her political power by serving as his secretary.

Madame de Pompadour was born in Paris, a member of a middle-class family. Her full name was Jeanne Antoinette Poisson. She received an excellent education and was introduced to high society at the home of a wealthy financier. In 1741, she married Lenormand d'Étoiles, the nephew of this financier. Five years later, she met King Louis at a masked ball. Louis fell in love with her, and she went to live in Versailles as his mistress. She received the title of the Marquise de Pompadour. She lived in Versailles for the rest of her life.

See also **Louis** (XV).

**Pompano** is the name of several species of saltwater fish. Pompanos belong to two unrelated families, the Carangidae and the Stromateidae. The first of these groups lives mainly in the warmer parts of the Atlantic Ocean. It includes the *African pompano* and the *great pompano,* which grow to over 100 centimetres in length. The *round pompano,* grows to 45 centimetres long. The best known Atlantic pompano is the *Florida pompano,* which grows to 45 centimetres in length and weighs about 3 kilograms. It is bluish above and silvery or slightly golden underneath. The body is oblong and flattened. It lives on small shellfish which it finds on the sea bed.



**The Florida pompano** has a flattened and oblong body. It is a valuable food fish.

The other pompano is the *Pacific pompano.* It lives off the western coast of North America, where it eats small shellfish. The Pacific pompano grows to 25 centimetres in length. It is silvery blue above and silver underneath, and has a deep, flattened body and a forked tail.

Pompanos are valuable food fish, highly prized for their rich flavour. Large numbers of pompanos are caught in nets.

**Scientific classification.** The African, great, round, and Florida pompanos belong to the family Carangidae. The African pompano is *Alectis crinitus;* the great pompano is *Trachinotus goodei;* the round pompano is *T. falcatus;* and the Florida pompano is *T. carolinus.* The Pacific pompano belongs to the family Stromateidae. It is *Peprilus simillimus.*

See also **Fish** (picture: Fish of coastal waters and the open sea).

**Pompeii** was an ancient city in Italy that disappeared after the eruption of Mount Vesuvius in A.D. 79. For hundreds of years, the city lay buried under cinders, ashes, and stone. Since Pompeii was rediscovered in the 1700's, much has been learned about its history. Each year, excavations in the area around Pompeii bring forth additional bits of ancient art and architecture. Much also has been learned about the everyday life of the ancient Romans, and about their manners and customs.

**Early days.** Pompeii was not a remarkable city. But it has become better known than many of the wealthier Roman towns because its ruins were so well preserved. Pompeii lay on a plateau of ancient lava near the Bay of Naples, less than 1.6 kilometres from the foot of Mount Vesuvius. For location, see **Italy** (physical map).

Scholars have not been able to identify Pompeii's original inhabitants. In the 500's B.C., the area came under the influence of Greek colonies along the coast. A mountain people called the Samnites occupied Pompeii in the 400's B.C. Pompeii remained a relatively unimportant village until the 200's B.C., when the town entered a prosperous period of building and expansion. Pompeii became a Roman community in 91 B.C.

Pompeii was built in the form of an oval about 3 kilometres around. A great wall with seven gates surrounded the city. The streets crossed each other at right angles, and were paved with blocks of lava. Ancient wheel ruts may still be seen in the pavements. In the centre of the city was the open square, or forum. It was surrounded by a group of important buildings. The city had a theatre, an amphitheatre, a gladiators' court, many temples, and three large public baths.

The fair blue skies of Pompeii attracted many wealthy Romans. They built great *villas* (homes) near the Mediterranean shore, where they could enjoy the mild, sunny climate. The Pompeiians built their villas with all the conveniences of a town in country surroundings. The large dwellings often consisted of two parts, the master's house and gardens, and the farmer's house with stables, barns, orchards, and fields. Most dwellings were built along the lines of a typical Roman house, with rooms grouped around the *atrium* (reception room). Town houses in Pompeii often had shops bordering the street. Archaeologists believe that most buildings had more than one storey. The upper parts of the buildings may have been constructed partly of wood. They projected out over the street, like French and English houses of the Middle Ages.

Pompeii carried on a prosperous trade in wine, oil, and breadstuffs. It was a market for the produce of a rich countryside, and its port had wide connections in the Mediterranean area. Pompeii was also an industrial centre, and produced a wide range of specialities, such as millstones, fish sauce, perfumes, and cloth. Its inhabitants included wealthy landowners, prosperous merchants and manufacturers, shopkeepers, artisans, and slaves.

**The eruption of Mount Vesuvius.** Earthquakes in A.D. 62 or 63 damaged Pompeii, Naples, and Herculaneum. Statues fell, columns were broken, and some buildings collapsed. Mount Vesuvius rumbled at this time. However, the people did not believe there would be more danger, and they repaired their cities. In the summer of A.D. 79, Vesuvius erupted with great vio-

**Mount Vesuvius** looms in the background over the once-thriving city of Pompeii, Italy. The cinders and ashes that buried the city aided in preserving its ruins for almost 2,000 years. About three-quarters of Pompeii has been uncovered.

lence. Streams of lava and mud poured into Herculaneum, covering the town and filling its harbour.

Hot ashes, stones, and cinders rained down on Pompeii. The darkened air was filled with poisonous gas and fumes. The Roman writer Pliny the Younger told in a letter how he led his mother to safety through the fumes and falling stones. His uncle, the writer Pliny the Elder, commanded a fleet that rescued some people from the disaster. He landed to view the eruption, and died on the shore.

The remains of about 2,000 victims out of a population of some 20,000 have been found in excavations at Pompeii. Some of the victims were trapped in their homes and killed by hot ashes. Others breathed the poisonous fumes and died as they fled. Archaeologists find the *shells* (moulds) of the bodies preserved in the hardened ash. By carefully pouring plaster into the shells, they can make detailed copies of the individuals, even to the expressions of agony on their faces.

Rather than the lava, showers of hot, wet ashes and cinders sprayed Pompeii. When these ashes and cinders dried, they covered and sealed up much of the city. Only the tops of walls and columns emerged above the waste. Survivors dug out valuables that they had left behind, and even took statues, marbles, and bronzes. However, later eruptions and erosion erased the last traces of the city.

Museo Archeologico Nazionale, Naples

**A floor mosaic** illustrates the Pompeiians' artistic skill. The mosaic depicts a dog wearing a collar and tied to a leash.

The eruption of Vesuvius destroyed not only Pompeii but also the nearby cities of Stabiae and Herculaneum (see **Herculaneum**). It changed the entire geography of the Campania region around Pompeii. It turned the Sarno River back from its course and raised the sea beach so that there was no way of locating the site of the buried city. Pompeii lay beneath the ash deposits for almost 1,700 years.

**Excavations.** The buried city was not completely forgotten. Peasants living in the area searched for hidden treasure. They did not excavate openly, but they tunnelled into the deposits and reached houses. In the 1500's, workers digging an underground tunnel to change the course of the Sarno River discovered parts of the amphitheatre, forum, and a temple. But no one paid much attention to these finds.

In 1748, a peasant was digging in a vineyard and struck a buried wall. His discovery came to the attention of authorities in Italy, and soon people began to carry on excavations in the region. At first, the diggers hoped to recover objects to enrich the museums of the kings of the Two Sicilies. For about 100 years, the search concentrated on important buildings, such as the forum, the amphitheatre, theatres, and the larger houses.

After 1860, Giuseppe Fiorelli served as director of the excavations. He instituted the first systematic uncovering of the whole city block by block. In the early 1900's, archaeologists decided not to remove treasures from the city, but to keep them and to restore buildings as much as possible to their original condition. The Italian government has given money for this work.

**Remains.** About three-quarters of Pompeii has now been uncovered. Visitors may see buildings as they stood almost 2,000 years ago. They may walk in and out of houses and up and down narrow lanes, just as the Pompeiians did. They may see the ruins of the ancient public square, with many of the surrounding buildings. They may see the old Temple of Jupiter, which was an ancient ruin at the time of the eruption. They may wander through the old Roman public halls, and admire the temples of Apollo and Fortuna Augusta.

Workers have uncovered a large part of the city wall. The disaster occurred during a local election campaign. Election slogans can still be seen on the walls of houses. Not many valuables have been found. Historians believe that the Pompeiians carried many of their possessions with them as they fled from the city. Workers have found bracelets, earrings, gems, and coins. They have also discovered household statues of silver, bronze, and ivory, as well as utensils of metal and glass. Many domestic treasures came to light near Boscoreale, a town near Naples. Many Pompeiian objects are on display in the National Museum at Naples.

See also **Vesuvius.**

**Pompey the Great** (106-48 B.C.) was an outstanding Roman general and statesman. He was the last obstacle in the rise to power of Julius Caesar.

Pompey was born in Rome, the son of a prominent nobleman. He grew up during the war between Gaius Marius and Lucius Sulla, and in 83 B.C. raised his own army of three legions to help the aristocrat Sulla against the forces of Marius in Italy. Then he wiped out the supporters of Marius in Sicily and Italy.

When Sulla died in 78 B.C., the consul Marcus Lepidus tried to repeal his conservative reforms. But Pompey opposed him and drove him out of Italy. The Senate then sent Pompey to Spain to put down an army of Marius's supporters. Pompey won an easy victory and returned to Rome in 71 B.C.

The conservative group in Rome did not wish to see Pompey gain further glory, but he was elected consul in 70 B.C. He broke with the conservatives and restored the powers of the tribunes that Sulla had taken away. Through popular support, Pompey was given the task, in 67 B.C., of clearing the Mediterranean Sea of pirates. In 66 B.C., he fought Mithridates of Pontus. Pompey defeated him and conquered eastern Asia Minor, Syria, and Palestine.

The Senate refused to approve his acts in Asia and his promises of land to his troops. So Pompey, Julius Caesar, and Marcus Crassus formed the First Triumvirate in 60 B.C. (see **Triumvirate**). They worked together against the Senate for several years. But Pompey became fearful of Caesar's ever-increasing power, and turned back to the conservatives. In the resulting civil war, Pompey was defeated in Italy and again at Pharsalus in Thessaly in 48 B.C. He escaped to Egypt, but was killed there by order of the Roman-dominated Egyptian government.

See also **Caesar, Julius; Crassus, Marcus Licinius; Mithridates VI; Sulla, Lucius Cornelius.**

**Pompidou, Georges Jean Raymond** (1911-1974), served as president of France from 1969 to 1974. He was elected after the resignation of President Charles de Gaulle. Pompidou was a member of the Union of Democrats for the Republic, a political party that supported de Gaulle.

Pompidou began his political career in 1944 as an adviser to de Gaulle, then a general head of the *provisional* (temporary) government in France. In 1946, Pompidou was appointed to the Council of State, a judicial and advisory body. He resigned in 1954 and entered private business. After de Gaulle was named premier in 1958, Pompidou resumed his political career as director of the general's personal staff. Later that year, de Gaulle became president. He appointed Pompidou to the Constitutional Council, which decides the legality of legislation. De Gaulle appointed Pompidou premier in 1962, but did not reappoint him after the parliamentary elections of 1968. Pompidou was elected to the National Assembly in 1967 and 1968.


**Juan Ponce de León** in 1513 led the first European expedition to what is now Florida, U.S.A. On the return voyage, Ponce de León landed on the Yucatán Peninsula of present-day Mexico.

Pompidou was the son of a schoolteacher and the grandson of a peasant. He was a professor of literature before entering politics.

**Ponape.** See **Pohnpei.**

**Ponce de León, Juan** (1474-1521), was a Spanish explorer. He led the first European expedition to reach what is now Florida, U.S.A. Ponce de León explored much of Florida while seeking an imaginary spring called the Fountain of Youth. This spring supposedly restored youth to old people who bathed in or drank its waters.

**Early career.** Ponce de León was born in Santervás de Campos, near the Spanish town of Palencia. He belonged to a noble family and served as a page in the court of King Ferdinand V and Queen Isabella I. In 1492, he fought with the Spanish troops that drove the Moors out of Granada, the last Muslim stronghold in Spain (see **Moors**).

In 1493, Ponce de León sailed on Christopher Columbus' second voyage to America. He became a soldier in the Spanish settlement on Hispaniola, in the West Indies. From 1502 to 1504, Ponce de León led the Spanish forces against the Amerindians in Higuey, the eastern province of Hispaniola. He defeated them and was appointed governor of Higuey as a reward.

Ponce de León left Hispaniola in 1508 to explore what became Puerto Rico. He discovered gold on the island and conquered it within a year. Ponce de León became governor in 1509.

Political rivals removed Ponce de León from office in 1512, so he sought a new adventure to gain more glory and wealth. King Ferdinand gave him permission to find and colonize an island called Bimini. This imaginary island was said to be the site of the Fountain of Youth. Amerindians had described the fountain, though their story resembled a European legend. According to medieval folklore, the spring was the Water of Life in the Garden of Eden, which supposedly lay in the Far East. The early Spaniards thought America was the Far East.

**Florida expeditions.** In 1513, Ponce de León led an expedition in search of Bimini. He explored the area of

the Bahamas and visited several islands that had been unknown to Europeans. In April 1513, he landed in Florida, which he thought was another island, and claimed it for Spain. According to one story, Ponce de León named the land Florida because of the many flowers that grew there. The Spanish word *Florida* means *full of flowers.* Another story says Ponce de León chose this name because he arrived there during the Easter season, which the Spaniards call *Pascua Florida.*

The explorer landed near the site of present-day St. Augustine. He sailed down the coast and explored almost the entire eastern shoreline and southern tip of Florida. His search for the Fountain of Youth led him partway up Florida's western coast. In June 1513, Ponce de León decided to return to Puerto Rico. During the voyage back, he landed on what is now Yucatán—which he thought was Bimini.

In 1514, Ponce de León sailed to Spain with news of his findings. King Ferdinand ordered him to colonize Bimini and Florida. The king also commanded him to rid the West Indies of the Carib Indians, who were fierce cannibals. Ponce de León returned to the New World in 1515 and fought the Carib tribe. The Indian fighting and various other activities, including another voyage to Spain, delayed his second expedition to Florida until 1521.

In February 1521, Ponce de León sailed from Puerto Rico with two ships that carried about 200 men and enough supplies to establish a colony. He landed on the west coast of Florida, probably near Charlotte Harbour. Indians attacked, and the Spanish leader was wounded by an arrow. Ponce de León and the few other survivors sailed to Cuba, where he died.

**Poncho.** See **Camping** (Clothing); **Inca** (picture: An Inca poncho); **Latin America** (Clothing).

**Pond** is a small, quiet body of water that is usually shallow enough for sunlight to reach the bottom. The sunlight enables rooted plants to grow across a pond bottom from shore to shore.

In many regions, ponds have a great variety of animal and plant life. The wind and streams carry in eggs, seeds, and organisms that develop into various forms of life. Pond animals include birds, crayfish, fish, frogs, insects, and turtles. Many ponds have rooted plants that either grow entirely underwater or have parts that extend above the surface. Leafy plants float on the surface. Microscopic animals and plants also thrive in most ponds.

**Pond life.** The plant and animal life found in a pond are determined largely by the pond's soil, quality of water, and location. Tropical ponds have different species of plants and animals than ponds in the Arctic, in mountains, or in prairies.

Ponds constantly undergo annual and long-term changes. Water levels normally rise and fall because of rainfall. As water levels change, the type and amount of plant growth also change. As the numbers and types of plants change, some animals may become numerous while others may decline in numbers.

Many natural processes help to maintain ponds. For example, floods and the movement of ice may deepen ponds. Human activities, on the other hand, can seriously harm ponds. For example, the quality of a pond rapidly deteriorates when people fill it with rubbish or other wastes.

**Kinds of ponds.** Ponds may be formed by natural conditions or by human beings. The chief kinds of natural ponds include *alpine ponds, bog ponds, ice-formed ponds, meadow-stream ponds, riverine ponds, sinkhole ponds,* and *tundra ponds.* Many farmers build a *farm pond* for flood control or recreation, or to secure a supply of water.

***Alpine ponds*** are gouged out by glaciers in mountainous regions. Many are located in the Alps in Europe and the Rocky Mountains in the United States.

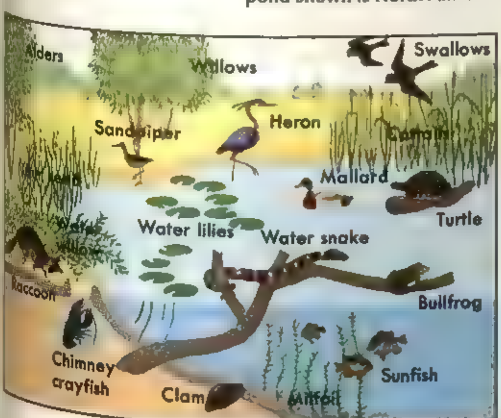
***Bog ponds*** form throughout the world, but especially in low-lying places in cooler regions of the Northern Hemisphere. These ponds have much peat and peat moss. The water has a high acid content.

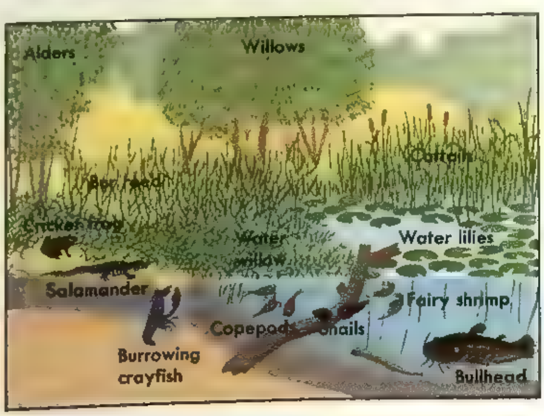
***Ice-formed ponds*** were created during prehistoric times by sheets of ice that crossed large regions of the world, particularly in the Northern Hemisphere. The scraping action of these sheets caused many basins that became ponds.

***Meadow-stream ponds*** develop where a slowly moving stream widens as it flows over a gently sloping land-

**The life of a pond**

The life of a pond changes as the water level changes. In a pond with high water, *left,* plants are less dense and animals that live best in open areas are abundant. When water is low, *right,* plants cover more of the pond and animals that thrive in dense plant growth are more common. The pond shown is North American, though many of the animals and plants can be seen elsewhere.



scape. Most meadow-stream ponds contain abundant life.

*Riverine ponds* develop where streams have stopped flowing through old channels. These ponds also occur where deposits of soil prevent water from entering channels.

*Sinkhole ponds* develop in regions that have much limestone beneath the surface of the soil. If underground water dissolves the limestone, the ground sinks and a pond may form.

*Tundra ponds* form in regions that have *permafrost* (permanently frozen ground). In such regions, areas of thawed ground may become ponds.

See also **Marsh; Plant** (picture: Plants of a freshwater pond); **Swamp.**

**Pond lily.** See **Water lily.**

**Pond-skater** is the name of several species of water insects that have piercing and sucking mouthparts. The common pond-skater is just under 2 centimetres long. It has two pairs of very long legs at the back and one pair of shorter, front legs. Pond-skaters use their long legs to row themselves quickly across the surface of the water. The front legs are used for catching small insects, which the pond-skater eats. They also eat dead insects. The underside of a pond skater is covered with fine silvery hairs that protects it from being wetted. Pond-skaters also have wings, and can fly well.

**Scientific classification.** Pond-skaters belong to the family Gerridae. The common pond-skater is *Gerris lacustris.*

**Pondicherry** (pop. 789,416) is a union territory of southeastern India. For location, see **India** (political map).

The territory consists of four districts that cover 492 square kilometres. The district of Pondicherry includes the port of Pondicherry, the capital of the territory. The district of Yanam is on the Coromandel Coast. The district of Mahe is on the Kerala coast. The fourth district is Karikal. The French were defeated by the British in the struggle for an Indian Empire in the early 1800's, but the four districts remained under French rule. This fact accounts for the scattered nature of the four districts.

Pondicherry is a well-cultivated, prosperous region, with good links to other parts of southern India. Visitors enjoy glimpses of French administrative, cultural, and judicial ways of life that have survived from the period of colonial rule. Alongside its ancient temples and monuments, Pondicherry is renowned for its Sri Aurobindo Ashram, and Auroville, the international township of humanity.

Most of the people are Hindus. The next largest group is formed by Muslims, except in the district of Pondicherry, where Christians rank next to Hindus. More than 55 languages are spoken in the territory, but only five are official. These languages are Tamil, Telugu, Malayalam, English, and French.

All the regions enjoy a coastal climate, with hot summers and cool winters. The rainy season lasts from July to September.

Almost half of the people of Pondicherry are engaged in agriculture. The main crops are cotton, peanuts, rice, and sugar cane. In the district of Mahe, coconuts are abundant.

**History.** Near Pondicherry are the remains of a Roman settlement, Arikamedu, which was a centre of trade between India and Rome in the A.D. 100's and 200's. Pondicherry later became a seat of traditional learning and Vedic culture (see **Veda**). Its earlier name was Vedapuri, after the worship of Vadapuriswara, the local name of the Hindu god, Shiva. A temple to the god was built and rebuilt many times. The earliest remains date back to the A.D. 900's. In the 900's and 1000's, the Chola kings built temples round Pondicherry.

In 1673, the French set up a trading centre at Pondicherry. This centre eventually became the chief French settlement in India. Dutch and British trading companies also wanted trade with India. Wars raged between these European countries and spilled over into the Indian subcontinent.

The Dutch captured Pondicherry in 1693 but returned it to France by the Treaty of Ryswick in 1699. The French acquired Mahe in the 1720's, Yanam in 1731, and Karaikal in 1738. During the Anglo-French wars (1742-1763), Pondicherry changed hands frequently. The British finally returned it to the French in 1814. When the British gained control of the whole of India in the late 1850's, they allowed the French to retain their few settlements in the country, including Pondicherry.

By 1946, the people of Pondicherry were demanding independence from France, and several political parties emerged. When it became known that the British would grant India independence in 1947, the people of Pondicherry demanded to join free India. After independence, India began negotiations with France over the Pondicherry merger issue. Finally, on Nov. 1, 1954, a popular government took over the administration of Pondicherry, making it a union territory of India.

**Pondweed** is a plant that grows in water, especially calm water. Pondweeds have small, green flowers that stand above the water. They often have two kinds of leaves. Firm, broad leaves float on top of the water; soft, narrow leaves are found under the water's surface. A North American species, Canadian pondweed, was introduced to Britain in the 1800's. Its stems grow below the surface, and may reach 3 metres in length. Canadian pondweed spreads very rapidly, and has blocked many canals and rivers.

**Scientific classification.** Pondweeds belong to the pondweed family, Potamogetonaceae. They make up the genus *Potamogeton.* Canadian pondweed belongs to the family Hydrocharitaceae. It is *Elodea canadensis.*

**Ponomarev, Boris Nikolaevich** (1905- ), was a leading official in the Communist Party of what was the Soviet Union. In 1955, he became chief of the party's International Department and was responsible for foreign policy. He was named a secretary of the party's Central Committee in 1961 and became a candidate member of the party's ruling Politburo in 1972. He left all these posts in 1985. Ponomarev was born in Zaraysk, near what is now Ryazan.

**Ponta Delgada** (pop. 21,813) is the most important city and port of the Portuguese Azores. Volcanic craters, gardens, and lakes make Ponta Delgada attractive. The refining of sugar beet is an important industry in the city. Ponta Delgada is on São Miguel Island.

See also **Azores.**

**Pontiac** (1720?-1769), a chief of the Ottawa tribe, was an important American Indian leader during the 1760's. Pontiac tried to unite the tribes of the Great Lakes area

Pontiac, *centre,* was a chief of the Ottawa Indians. During the 1760's, he tried to unite tribes of the Great Lakes and of the Ohio and Mississippi valleys against British settlers in North America.

and of the Ohio and Mississippi valleys in order to maintain Indian control of those regions.

During the French and Indian War (1754-1763), Pontiac led his tribe in fighting on the side of the French against the British. But he opposed the claims of both sides to the territory west of the Allegheny Mountains. After the British achieved major victories over the French in 1760, they sent a small force to take over the abandoned French forts near the Great Lakes. Pontiac let the British pass through the area. However, after he received promises of help from French traders and officers, he made plans with other tribes of the region to attack the posts.

In the spring of 1763, the tribes captured nine British forts in what became known as Pontiac's War. Pontiac led the attack on Fort Pontchartrain, at what is now Detroit. He besieged the post for about five months. However, France sent no help to Pontiac and his forces, and the Indians could not continue the war without more guns and ammunition.

Pontiac was probably born in northern Ohio, U.S.A. He became a priest of a religious group called the Midewiwin, or Grand Medicine, Society. He agreed with the Indian holy man known as the Delaware Prophet, who preached that Indians should abandon all trade with white people. Pontiac was mysteriously killed at an Indian religious centre in Cahokia, Illinois.

See also **Indian wars** (Pontiac's War).

**Pontifex** was a member of the board of officials that supervised the religious activities of ancient Rome. The board determined when religious holidays and ceremonies would take place. Romans consulted the board to learn whether planned activities followed sacred law. The *pontifex maximus,* the highest religious authority, headed the board. The emperor later held this position.

Pontifices were appointed for life. The king appointed them in early Rome. In the later years of the republic, members were nominated by the board and elected by an assembly. There were originally 3 pontifices. But by the 40's B.C., the number had increased to 16.

**Pontiff.** See Pope.

**Pontine Marshes** is a swamp area in Italy that covers about 70,820 hectares south of Rome, between Cisterna and Terracina. For centuries, the Pontine Marshes were responsible for widespread malaria epidemics in central Italy. The early Roman emperors, and later Pope Sixtus V, drained the parts above sea level by digging drainage canals. In the 1930's, Benito Mussolini, the ruler of Italy, had the rest of the marshes drained by a system of dikes and pumps. In addition to getting rid of the malaria menace, drainage of this area made available rich farmland. Grain and various other agricultural products now are grown in the Pontine region. Cattle and sheep are also raised in this area. Towns built on this reclaimed land include Aprilia, Latina, Pomezia, Pontinia, and Sabaudia.

**Pontius Pilate.** See Pilate, Pontius.

**Pontoon bridge** is a bridge supported by *pontoons* (flat-bottomed boats), metal cylinders, or other portable floats. A pontoon bridge is sometimes called a *ponton* bridge. A flooring of timber or lightweight metal panels is usually laid across a pontoon bridge. Pontoon bridges are especially important during wartime. These bridges are built to replace those that have been destroyed by enemy forces. Special pontoon-laying troops bridge streams with mechanical exactness, even under fire. The soldiers lay the flooring, section by section, fastening it securely to the pontoons. Pontoon bridges are usually of limited strength, although sufficient to carry ordinary road vehicles. Soldiers must break step in crossing them to prevent the swaying of the bridge caused by marching in time.

The importance of pontoon-bridge building was shown in Europe during World War II (1939-1945). Retreating troops blew up many bridges across important rivers. Engineers of pursuing armies built pontoon bridges, permitting troops and mechanized equipment to cross the rivers.

In the United States, pontoons have been used for permanent bridges in places where deep water makes pier construction too expensive. Three large concrete floating bridges have been built in Washington state. One of these has the longest floating span in North America. This span stretches 2,291 metres across Lake Washington.

**Pontoppidan, Henrik.** See Nobel Prizes (table: Nobel Prizes for literature—1917).

**Pontus** was an ancient area on the south shore of the Black Sea in Asia Minor. It reached its greatest importance under King Mithridates VI (120?-63 B.C.). At that time, it included other nearby areas in what is now Turkey, and lands north of the Black Sea in what is now southern Russia. Mithridates fought three wars against Rome. After the last one, in 63 B.C., the victorious Roman general Pompey brought Pontus under Roman rule. In A.D. 1204, Pontus gained independence from the East

Roman Empire. The kingdom remained independent until 1461, when it became part of the Ottoman Empire.

See also **Mithridates VI.**

**Pontus Euxinus.** See **Black Sea.**

**Pony.** See **Horse** (Ponies); **Shetland pony.**

**Pony club branches** are organized to teach young people to ride and to know and care about horses and horsemanship. All branches that use the name *pony club* are affiliated to the Pony Club, which has more than 350 branches in Britain and more than 1,300 in other countries. The Pony Club has in total about 40,000 members.

The various branches of the Pony Club often compete with one another. In addition, the club organizes national events such as the Pony Club Horse Trials, which include *dressage* (discipline and control of a horse), polo, showjumping, and tetrathlon events. The Pony Club Mounted Games Championship is held for the Prince Philip Cup. The championship final takes place at the Horse of the Year Show, which is held at Wembley Stadium, London, in the autumn.

The Pony Club is part of the youth service of Britain, and is a member of the Standing Conference of National Voluntary Youth Organizations. Riders can take part in the Duke of Edinburgh's Award Scheme and win silver and gold awards in the section for *Expeditions* (see **Duke of Edinburgh's Award**).

**Pony express** was a United States mail delivery service that operated between St. Joseph, Missouri, and Sacramento, California, in 1860 and 1861. The pony express consisted of relays of men riding fast ponies or horses that carried letters and small packages across a 3,164-kilometre trail. These riders could deliver mail to California in 10 days or less, faster than any other mail service of that time. Previously, mail travelled between California and areas east of the Mississippi River only by boat or stagecoach. A one-way delivery between the farthest points took more than three weeks.

Early in 1860, Senator William M. Gwin of California and William H. Russell, a Missouri businessman, agreed to establish an express mail service between St. Joseph and the west coast. St. Joseph then served as the western terminal of the U.S. railway system. Russell's large freighting firm—Russell, Majors, and Waddell—backed the project.

Russell and his associates collected about 400 fast horses, hired approximately 80 riders, and established 190 pony express stations. These stations stood 16 to 24 kilometres apart. The pony express route ran along the Platte River in what is now Nebraska, to South Pass and Fort Bridger, both now in Wyoming. Then it turned south to the Great Salt Lake. South of Salt Lake City, Utah, it headed west across the salt desert to the Sierra Nevada. The pony express began its first run on April 3, 1860. At first, it charged 5 U.S. dollars to send 14 grams of mail. The rate later fell to 1 U.S. dollar for the same weight.

Only young, lightweight men served as pony express riders. Many of them were teenagers. A day's work consisted of a trip of 120 kilometres or more. The rider mounted a fresh horse at each station along the trail. He ended his workday when he reached a *home station*, where another rider took his place. Pony express riders were paid from 100 to 150 U.S. dollars a month.

The pony express rider carried mail in a specially designed leather saddlebag. The saddlebag fitted over the saddle, and only the rider's weight held it in place. As a result, the rider could change horses in about two minutes.

The pony express typically forwarded mail at a rate of more than 320 kilometres a day. The fastest run between St. Joseph and Sacramento came in March 1861. That month, a copy of President Abraham Lincoln's first address to Congress arrived in Sacramento just 7 days and 17 hours after leaving St. Joseph.

The pony express ran day and night. Riders worked in all kinds of weather and faced the threat of Indian attacks. Most of the riders carried a pair of pistols and a knife. Only one rider in the history of the pony express was killed by Indians.

Oil painting on canvas (1900); Thomas Gilcrease Institute of American History and Art, Tulsa, Oklahoma, U.S.A.

**A pony express rider** switches to a fresh mount and begins another step of his dangerous dash across the West of the United States. The American artist Frederic Remington captured this scene in his painting, *The Coming and Going of the Pony Express.*

The transcontinental telegraph ended the major need for the pony express. It opened on Oct. 24, 1861, and the pony express officially closed two days later. Russell's freighting firm lost more than 100,000 U.S. dollars on the pony express.

**Poodle** is the name of a breed of intelligent, friendly dog. It was once used as a hunter and retriever, but is no longer classed as a sporting dog. The breed is thought to have originated in Germany during the 1500's

**The standard poodle,** *above,* is one of three varieties of poodle. Like the toy and miniature varieties, it has a curly coat.

but it may have come from France, Denmark, or Russia. Poodles are popular as pets in many countries.

Poodles may be white, black, grey, blue, brown, or apricot. Their hair is curly or frizzy, and the coat is usually clipped in any of several styles. The three varieties of poodles are classified by shoulder height. The *toy poodle* is 25 centimetres or under; the *miniature poodle* is from 25 to 38 centimetres; and the *standard poodle* is over 38 centimetres. Poodles weigh from 1.5 to 27 kilograms.

**Pool.** See **Billiards and Snooker.**

**Poole** (pop. 130,900) is a port and local government district situated on the coast of Dorset, England. It lies on the north side of Poole Harbour, which is formed by the projection of the Isle of Purbeck. Poole has a beach made up of both shingle and sand, with facilities for bathing. It is an important centre for sailing and has eight yacht clubs.

Poole is a popular tourist resort. It also has several historic buildings. Scaplen's Court, also known as the Old Town House, was built in the 1400's and 1500's. The Guildhall at Poole was founded in 1761. Pottery is made from the local clay at the Poole Pottery. Boat building and fishing are also traditional local industries. Other products of Poole include caravans, chemicals and pharmaceuticals, electronical goods, engineering goods, and processed foods.

**Poor Clares, Order of.** See **Franciscans.**

**Poor laws** were designed to give help and relief to poor people in Britain. Today, the need for such relief has been reduced by national insurance and pension schemes, both of which are aspects of the welfare state. See **United Kingdom, History of the** (Social developments; The welfare state).

In the Middle Ages, churches, monasteries, and charities provided relief for the poor and aged. In the late 1500's and early 1600's, Parliament passed various poor laws forcing local authorities to carry out their duties towards the poor. An act of 1601 compelled parish officials, called *overseers of the poor,* to buy material to provide work for the unemployed in their parish. The authorities built *poorhouses* or *workhouses* to give poor people work.

The British Parliament passed the Poor Law Amendment Act in 1834. Under this act, Parliament set up a *Poor Law Commission* and created *boards of guardians,* responsible for each district, to run the workhouses and provide outside relief for the poor. In 1930, Parliament abolished the boards of guardians and placed the duty of poor relief in the hands of county and county borough councils.

After World War II (1939-1945), the Labour government created a Ministry of National Insurance, a Ministry of Pensions, and a National Assistance Board. These organizations were specially designed to tackle poverty on a national scale. Their work was taken over by the Department of Health and Social Security, which was created in 1968.

**Poor Richard's Almanac** was an almanac written and published by Benjamin Franklin (see **Almanac**). The famous American statesman created the almanac early in his career, when he was a printer and publisher in Philadelphia. Franklin issued the almanac for every year from 1733 to 1758.

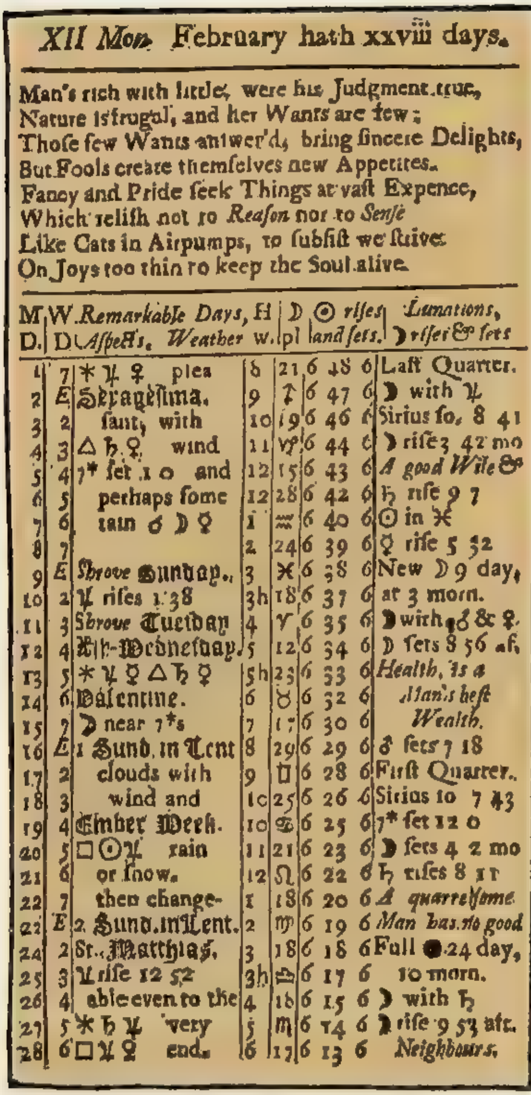
Franklin wrote the almanac under the name of Richard Saunders, an imaginary astronomer. Like other almanacs of its time, *Poor Richard* included such features as astrological signs, practical advice, jokes, poems, and weather predictions. At first, Richard had little wit or humour. But as his character developed, he became a clever spokesman for Franklin's ideas on thrift, duty, hard work, and simplicity. *Poor Richard's Almanac* grew into one of the most popular and influential works printed in colonial America. Franklin published the almanac under his own name.

In each edition of the almanac, Richard offered his readers a number of proverbs. Many of these sayings became famous, and people still quote them today. These sayings include:

"A penny saved is a penny earned."
"God helps them that help themselves."
"Early to bed and early to rise,
Makes a man healthy, wealthy, and wise."

Such proverbs expressed Franklin's philosophy that foresight, wise spending, and plain living are not only good qualities, but also lead to success. This philosophy greatly influenced American thought before and after the American Revolution (1775-1783).

Franklin enlarged the almanac for the 1748 edition and called it *Poor Richard Improved.* In the preface to the final edition, published in 1757, he collected many of Richard's proverbs on how to succeed in business and public affairs. The preface, called "The Way to Wealth," was reprinted separately and was widely read in England and France as well as in America. However, this collection of proverbs provides a misleading view of Franklin's wisdom and character because it focuses



XII Mon. February hath xxviii days.

Man's rich with little, were his Judgment true,
Nature is frugal, and her Wants are few;
Thoſe few Wants anſwer'd, bring ſincere Delights,
But Fools create themſelves new Appetites.
Fancy and Pride ſeek Things at vaſt Expence,
Which relish not to *Reaſon* nor to *Senſe*
Like Cats in Airpumps, to ſubſiſt we ſtrive
On Joys too thin to keep the Soul alive.

| M. D. | W. D. | *Remarkable Days,* *Aſpects,* *Weather* | H w. | ☽ pl | ☉ *riſes and ſets.* | *Lunations,* ☽ *riſes & ſets* |
|---|---|---|---|---|---|---|
| 1 | 7 | ✱ ♃ ♀ plea | 8 | 21 | 6 48 6 | Laſt Quarter. |
| 2 | E | Sexageſima. | 9 | ♐ | 6 47 6 | ☽ with ♃ |
| 3 | 2 | ſant, with | 10 | 19 | 6 46 6 | Sirius ſo. 8 41 |
| 4 | 3 | △ ♄ ♀ wind | 11 | ♑ | 6 44 6 | ☽ riſe 3 42 mo |
| 5 | 4 | 7* ſet 1 0 and | 12 | 15 | 6 43 6 | *A good Wife &* |
| 6 | 5 | perhaps ſome | 12 | 28 | 6 42 6 | ♄ riſe 9 7 |
| 7 | 6 | rain ☌ ☽ ♀ | 1 | ♒ | 6 40 6 | ☉ in ♓ |
| 8 | 7 | | 2 | 24 | 6 39 6 | ☿ riſe 5 52 |
| 9 | E | *Shrove* Sunday. | 3 | ♓ | 6 38 6 | New ☽ 9 day, |
| 10 | 2 | ♃ riſes 1 38 | 3h | 18 | 6 37 6 | at 3 morn. |
| 11 | 3 | *Shrove* Tueſday | 4 | ♈ | 6 35 6 | ☽ with ♂ & ♀. |
| 12 | 4 | Aſh-Wedneſday. | 5 | 12 | 6 34 6 | ☽ ſets 8 56 af. |
| 13 | 5 | ✱ ♃ ☿ △ ♄ ♀ | 5h | 25 | 6 33 6 | *Health, is a* |
| 14 | 6 | Valentine. | 6 | ♉ | 6 32 6 | *Man's beſt* |
| 15 | 7 | ☽ near 7*s | 7 | 17 | 6 30 6 | *Wealth.* |
| 16 | E | 1 Sund. in Lent | 8 | 29 | 6 29 6 | ♂ ſets 7 18 |
| 17 | 2 | clouds with | 9 | ♊ | 6 28 6 | Firſt Quarter. |
| 18 | 3 | wind and | 10 | 25 | 6 26 6 | Sirius ſo. 7 43 |
| 19 | 4 | Ember Week. | 10 | ♋ | 6 25 6 | 7* ſet 12 0 |
| 20 | 5 | □ ☉ ♃ rain | 11 | 21 | 6 23 6 | ☽ ſets 4 2 mo |
| 21 | 6 | or ſnow. | 12 | ♌ | 6 22 6 | ♄ riſes 8 11 |
| 22 | 7 | then change- | 1 | 18 | 6 20 6 | *A quarrelſome* |
| 23 | E | 2 Sund. in Lent. | 2 | ♍ | 6 19 6 | *Man has no good* |
| 24 | 2 | St. Matthias. | 3 | 18 | 6 18 6 | Full ● 24 day, |
| 25 | 3 | ♃ riſe 12 52 | 3h | ♎ | 6 17 6 | 10 morn. |
| 26 | 4 | able even to the | 4 | 16 | 6 15 6 | ☽ with ♄ |
| 27 | 5 | ✱ ♄ ♃ very | 5 | ♏ | 6 14 6 | ☽ riſe 9 53 aft. |
| 28 | 6 | □ ♃ ♀ end. | 6 | 17 | 6 13 6 | *Neighbours.* |

**This page from *Poor Richard's Almanac*** opens with the moral saying that "Man's rich with little, were his Judgment true; Nature is frugal, and her Wants are few."

chiefly on material gain and proper conduct. Many of Franklin's other sayings reveal that he also had a witty and sometimes sceptical mind.

See also **Franklin, Benjamin.**

**Pop.** See **Soft drink.**

**Pop art** is an art movement that originated in England in the 1950's but became best known in the United States during the 1960's. Many pop artists use common, everyday, "nonartistic" commercial illustrations as the basis of their work. Many of the works these artists produce are satirical or playful in intent. However, their uses of forms and themes from mass culture are intended to devalue what they consider to be unnecessarily difficult and private aspects of traditional fine art forms.

Pop artists have no single way of working. Some are fascinated by the bold, simple patterns of commercial illustrations. For example, Andy Warhol made exact painted copies of soup cans, repeating them over and over in the same painting. James Rosenquist and Tom Wesselmann use advertising art as the basis of paintings with their own complex, often humorous and frequently critical designs. Several pop artists have made three-dimensional constructions that resemble and embrace the world of ordinary objects.

**Related articles** in *World Book* include:

| | |
|---|---|
| Hockney, David | Painting (Pop art: picture) |
| Johns, Jasper | Rauschenberg, Robert |
| Lichtenstein, Roy | Warhol, Andy |
| Oldenburg, Claes | |

**Popcorn** is a type of maize that is a popular snack food in the United States. Popcorn has smaller, harder kernels than other types of maize. When heated to a temperature of about 200° C, popcorn kernels burst with a popping sound into white, fluffy flakes. Popcorn is a good source of dietary fibre and, when eaten plain, is low in calories.

Popcorn kernels have a hard outer shell that surrounds a mass of moist starch. When the kernels are heated, the moisture turns into steam. The steam builds up pressure within the shell, eventually causing the kernel to burst and the inside to puff out. The best popcorn kernels consist of 13½ per cent moisture and expand to 30 to 40 times their original size when popped.

Popcorn is native to North and South America and is one of the oldest forms of maize. American Indians grew popcorn for a few thousand years before the arrival of European explorers in the 1400's and 1500's. Indians used popcorn for food and decoration and in religious ceremonies. Today, the United States grows nearly all the world's popcorn.

**Scientific classification.** Popcorn belongs to the family Poaceae (Gramineae). It is *Zea mays everta*.

See also **Maize** (Kinds of maize; picture).


Wallraf-Richartz-Museum, Cologne, Germany

**Pop art painting,** like the comic-strip panel *M-Maybe* (1965) by Roy Lichtenstein, shows the influence of commercial art.

The pope is the spiritual leader of millions of Roman Catholics throughout the world. He also rules Vatican City, an independent state within the city of Rome. Each Christmas Day, thousands of people gather in St. Peter's Square in Vatican City to receive the pope's blessing.

# Pope

**Pope** is the head of the Roman Catholic Church. The church regards the pope as its visible head and Jesus Christ as its invisible and supreme head. Roman Catholics believe that Jesus established the office of pope when He said to the apostle Simon, who was also called Peter:

> And I say also unto thee, That thou art Peter, and upon this rock I will build my church; and the gates of hell shall not prevail against it (Matt. 16: 18).

Except for brief periods of vacancy, there has been an unbroken line of popes beginning with Peter. John Paul II, who became pope in 1978, is generally considered the 264th pope.

The word *pope* comes from the Greek word *pappas,* which is a child's name for its father. The pope is also called the *pontiff,* from the Latin word *pontifex,* a term used for a member of the council of priests in ancient Rome.

The word *papacy* refers to the government of the Roman Catholic Church with the pope as supreme head. The term is also used for the office of pope.

In early church history, bishops in general were often called pope. Beginning in the early 500's, the title in the Western church came to be used exclusively for the bishop of Rome. According to tradition, Peter travelled to Rome and became the city's first bishop, giving special status to Rome and to its office of bishop.

The pope lives in the Vatican Palace in Vatican City, an independent state that lies within the city of Rome. Vatican City is also called the *Holy See* or *Apostolic See. See* is a term for the official home of a bishop. *Holy See* is also used as another term for the papacy, especially when referring to its functions and *jurisdiction* (authority).

The pope is elected for life. He can resign, but he cannot be *deposed* (forcibly removed from office). Officially, any practicing Roman Catholic male is eligible to be elected pope. However, since the 1300's, the pope has always been chosen from among high-ranking clergymen called *cardinals.* Together, the cardinals make up the Sacred College of Cardinals, and serve as the pope's chief advisers.

Almost all popes have been Italian. In 1978, John Paul II became the first non-Italian pope since 1523. John Paul was born in Poland.

### The powers of the pope

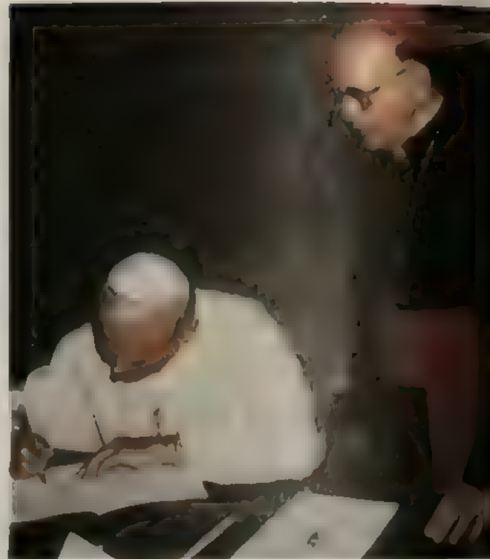
The pope has two basic types of powers: spiritual and temporal. Spiritual powers are concerned with faith, morals, religious practices, and church government. Temporal powers involve the civil administration of Vatican City as an independent state.

Roman Catholics believe that the pope is *infallible* (incapable of error) when he speaks for all the church on matters of faith and morals. The pope is not considered infallible on other aspects of church affairs. However, he

does have absolute jurisdiction. For example, he can make laws for the entire church. He appoints cardinals, appoints or removes bishops, establishes and divides *dioceses* (church districts headed by bishops), and approves new religious *orders* (brotherhoods or sisterhoods).

For a period during the Middle Ages, the pope was the dominant temporal leader in the West. From 756 to 1870, the papacy controlled provinces and cities in central Italy, including Rome, called the Papal States. Today, the pope's temporal responsibilities are limited to ruling Vatican City, the smallest independent country in the world. Vatican City has an area of 44.1 hectares and a population of about 1,000. It has its own flag, coins, stamps, public works, and communications systems. The pope sends representatives, called *nuncios*, to other independent states and receives foreign diplomats.

As the leader of hundreds of millions of Roman Catholics around the world, the pope can speak as an influential international leader. Popes have spoken on a variety of religious and *secular* (nonreligious) subjects. Modern popes have issued strong, sometimes controversial, statements on such political issues as government tyranny, and on birth control and other matters involving the family.



**As a world leader,** the pope often comments on international affairs. In 1985, John Paul II signed an encyclical calling for improved relations between Eastern Europe and Western Europe.

## Titles, clothing, and symbols

The pope is addressed as "Your Holiness." He speaks of himself in official documents as "servant of the servants of God." Each man who is elected pope traditionally takes a new name for use during his reign. Most popes choose the name of an earlier pope whom they admire.

Like other clergy, the pope wears distinctive religious clothing called *vestments*. In general, his garments are the same style as those worn by a bishop. The pope's everyday clothing includes black trousers, a collarless white shirt, a clerical collar, a white skullcap, and a long white garment called a *cassock* with a sash. For public appearances, the pope may wear a short red cape called a *mozzetta*, and a circular collar of white wool, called a *pallium*, which rests on the shoulders. The pallium is embroidered with six black crosses. The pope also wears low red shoes.

The pope wears a cross made of gold, called a *pectoral cross*. The pope's jewellery also includes a ring known as the *fisherman's ring*. It shows Peter in his occupation as a fisherman and symbolizes the pope's role as a "fisher of men."

## The daily life of the pope

The pope lives in the Vatican Palace most of the year. During the summer, he moves to the papal villa in the small town of Castel Gandolfo, in the Alban Hills south

**The daily life of the pope** includes meeting with groups of Roman Catholics who visit Rome. In this picture, John Paul II greets a gathering of Boy Scouts. The pope also holds regular receptions called audiences in Vatican City for visitors.

Paul VI officiating at a Mass

**The pope's vestments** for saying Mass include a white skullcap, a woollen collar called a *pallium,* and a sleeveless garment called a *chasuble* worn over a long white cassock.

... of Rome. This section describes a typical day in the life of John Paul II.

The pope rises each morning by 6 a.m. His simply furnished bedroom has a bed with a red, hand-embroidered bedspread and a desk where the pope does most of his writing. The room also has a kneeler that the pope uses every morning and evening for private prayer.

After dressing and completing his private prayers, the pope is met at his bedroom by two priest-secretaries who escort him to the nearby papal chapel for a 7 a.m. Mass. Foreign guests often attend this Mass, and the pope may celebrate it in their language.

After Mass, the pope has breakfast. He is then briefed by assistants called *prefects* on his daily schedule and important diplomatic developments. John Paul then attends meetings and handles paperwork before holding private *audiences* (receptions) that begin at 11 a.m. Visitors to Rome and people who have business with the Holy See attend these audiences, which last 15 to 20 minutes. The pope also holds a general audience every Wednesday that may attract up to 12,000 people indoors and 60,000 outdoors in St. Peter's Square in Vatican City.

The pope eats lunch at about 1:30 or 2 p.m., usually with guests. After lunch he rests briefly. He then jogs or walks briskly in the palace gardens. If he is at Castel Gandolfo, the pope may swim in the villa pool.

Additional meetings and paperwork occupy most of the pope's time until the evening meal is served, around 8:30 p.m. At about 10:30 p.m., the pope returns to his desk for at least another hour of paperwork. After evening prayers, the pope goes to bed at about midnight. John Paul averages under six hours of sleep a night.

The pope's salary has never been publicly revealed. The cardinals receive the equivalent of 18,000 U.S. dollars a year, plus gifts, and observers of papal life estimate that the pope probably receives the same amount. Other papal income comes from donations, especially the annual "Peter's Pence" contributions from Catholics throughout the world.

## The election of a pope

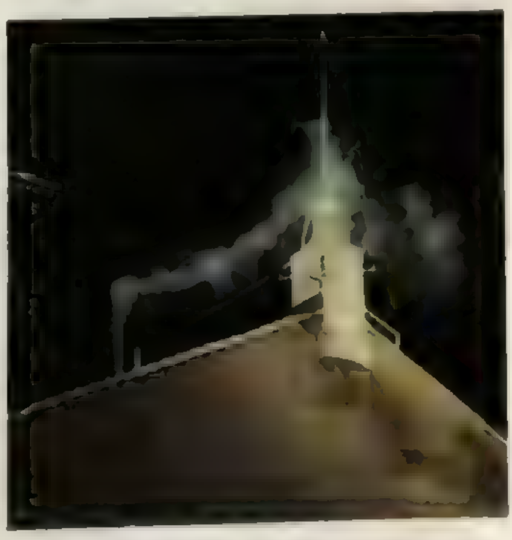
**Early days.** During the history of the papacy, procedures for electing a new pope have varied. Until the 300's, popes were elected by a kind of local election involving clergy from Rome and nearby areas. For many centuries, kings, emperors, and other secular leaders interfered in the election process and tried to influence the outcome. At various times an *antipope* (a man improperly elected to be pope) set himself up in opposition to the pope who had been elected legally. Sometimes emperors or factions within the church itself supported antipopes.

Major features of the present electoral procedure date back to 1059, when Pope Nicholas II (1059-1061) declared that papal electors must be cardinals. In 1179, Pope Alexander III (1159-1181) presided over the Third Lateran Council, which established that all cardinals had an equal vote, and election required a two-thirds majority. In 1274, Pope Gregory X (1271-1276) took steps to prevent election delays by requiring all cardinals to meet within 10 days of a pope's death. They had to remain together in strict seclusion from the outside world until they elected a new pope. By the late 1500's, most electoral procedures now in effect had been adopted.

**Present procedures.** When a pope dies, the dean of the Sacred College notifies all cardinals of the vacancy. They are called to a *conclave* (meeting) at Vatican City that must begin no more than 20 days after the pope's death.

Election of a pope can take place in three ways. The most common way is by ballot. A pope can also be elected by unanimous voice vote or by a unanimously chosen committee of 9 to 15 delegates.

The election process by ballot is carefully controlled. Blank ballots are prepared and distributed. By lot, the cardinals choose from their group three who collect the ballots of the infirm, three *tellers* (counters of the votes),



**The election of a pope** is announced to the outside world by white smoke emerging from a chimney in Vatican City. The smoke comes from the burning of the ballots after the final vote.

Detail of a tempera painting on wood (early 1300's) by Giotto; Pinacoteca Vaticana, Rome

**Saint Peter** is considered the first pope. Roman Catholics believe that Jesus Christ established the office through Peter.

Fresco (mid-1600's) by Il Borgognone; Santa Maria della Passione, Milan, Italy

**Saint Gregory I** established the temporal power of the papacy through his skill as a statesman and administrator.

Fresco (1200's) by an unknown artist in the Holy Cave in Subiaco, Italy

**Innocent III** was the most powerful of all medieval popes. He influenced the political affairs of much of Europe.

and three reviewers of the results. After these officials are chosen, each cardinal writes the name of one preference on a ballot. Then each cardinal, in order of seniority, approaches an altar to pledge his integrity of purpose. He then places the folded ballot in a receptacle covered by a plate. Only cardinals under the age of 80 may vote. After all the votes are submitted, the three tellers read each ballot. The last teller reads the results aloud to the entire assembly of cardinals. Two votes are taken every morning and two every afternoon until a two-thirds plus one majority is obtained.

After the required majority has been reached, the dean asks the man selected if he accepts his election. If he does, he immediately has full and absolute jurisdiction over the entire church. The dean asks the pope what name he chooses and announces the name to all the cardinals. The cardinals then pay their respects to the new pope.

A large crowd usually gathers in St. Peter's Square to await the outcome of the election. They follow the balloting by watching the smoke that comes from a chimney on the palace roof. All ballots are burned after counting. If the necessary majority is not reached, the ballots are burned in a way that creates black smoke. After the final vote, the ballots are burned in a manner that creates white smoke to signal the election. The oldest cardinal announces the choice to the waiting crowd, and the pope delivers his first blessing to Rome and to the world. An official coronation is held at a later date.

### History

**The early papacy.** During the early years of Christianity, each local church was independent and led by its own elected bishop. Bishops communicated with one another through letters and personal visits, but they did not have to consult one another on religious questions. Consulting the bishop of Rome was not required, but many churches did so because of Rome's special place in Christian history. As early as the 90's, Pope Saint Clement I (about 92-101) was asserting the Roman See's *primacy* (superior authority) over the other churches.

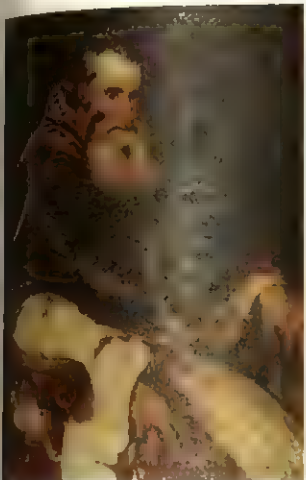
Christians gained freedom of worship in the Roman Empire during the reign of Constantine the Great in the early 300's. The status of the bishop of Rome increased as a result. However, Constantine moved his imperial capital from Rome to Constantinople (now Istanbul, Turkey), and the city was dedicated in 330. After this move, some church leaders in the East came to believe that the See of Constantinople should have equal authority with Rome. Pope Saint Leo I (440-461) argued forcefully for the primacy of the Roman See. He believed that through divine and Biblical authority, the bishop of Rome inherited a "fullness of power" from Peter and was the apostle's legitimate and legal successor.

**The early Middle Ages.** By the 400's, the Roman Empire in the West was threatened with destruction from repeated invasions by barbarian tribes. These invasions reduced papal authority, which was also weakened by the growth of *heresy* (false doctrine) among Christians in large parts of Africa and Spain.

Pope Saint Gregory I (590-604) defended Italy from barbarian attack. He organized papal lands throughout Italy and Sicily, and collected enough taxes to feed the Roman population and pay Roman soldiers. In the 590's, Gregory made peace with the invading Lombard tribe, which was threatening Rome. Gregory's leadership established the temporal power of the papacy. The conversion of England to Christianity was begun during his reign, and he strengthened the church in Spain, France, and northern Italy.

Hundreds of years of conflict between the Eastern and Western churches led to a historic dispute between Pope Saint Nicholas I (858-867) and Photius, the patriarch of Constantinople. A complete *schism* (split) between the Eastern and Western churches took place in 1054, during the papacy of Pope Saint Leo IX (1049-1054).

Other internal threats to the survival of the papacy emerged during the 800's and 900's. The papacy's reputation and influence declined as Roman nobles tried to control the office through *simony* (selling of church of-



Oil painting on wood (1543) by Titian; Museo Capodimonte, Naples, Italy

**Paul III** was a Renaissance pope who helped begin the Catholic Reformation by calling the Council of Trent.

Oil painting on canvas (1740s) by Giuseppe Maria Crespi; Pinacoteca Vaticana, Rome

**Benedict XIV** was admired for his high moral character and his support of religious and secular education.

**Pius XII** was one of the most active popes in history, updating and revising many church practices and customs.

fices), intrigue, and even assassination. Eventually, beginning in the 900's, monks from the Benedictine monastery at Cluny, France, led a reform movement to eliminate simony and the practice of clergy being married. By religious law, clergy were supposed to be *celibate* (unmarried).

Pope Nicholas II (1059-1061) supported the Cluniac reforms. He restricted the rights of married priests and issued a decree that papal electors must be cardinals, which was directed mainly at simony.

**The peak of papal power.** Reforms continued under Pope Saint Gregory VII (1073-1085), who issued strongly worded decrees against simony and *lay investiture.* Through lay investiture, secular rulers granted church offices to the clergy of their choice. Lay investiture had given secular leaders considerable influence in church affairs and often allowed unqualified people to receive important religious positions. In a document issued in 1075, Gregory claimed that the pope had the power to depose both temporal and spiritual leaders. He stated that the pontiff held legislative and judicial power over all Christians.

Pope Innocent III (1198-1216) was the most powerful of all medieval popes. He influenced the political affairs of much of Europe and encouraged the establishment of the Franciscan and Dominican religious orders. Innocent was a great administrator and *jurist* (legal expert). He made "Vicar of Christ" the exclusive title for the pope, replacing older titles such as "Vicar of St. Peter."

The papal claim to primacy was expressed dramatically by Pope Boniface VIII (1294-1303) in a *bull* (papal decree) of 1302 called *Unam sanctam.* In the bull, Boniface claimed that every human being's salvation depended upon submission to the authority of the pope. Boniface saw the pope as Christ on earth, the exclusive instrument of salvation.

**The troubles of the papacy.** During much of his reign, Boniface VIII came into conflict with the French king, Philip IV. In 1303, soldiers led by a French official took the pope prisoner at his family home at Anagni, Italy. Although the pope was released after three days, the episode symbolized the end of papal domination in the secular world. From 1309 to 1377, the popes resided at Avignon, in what is now France. This period, sometimes called the *Babylonian Captivity,* introduced a time of turmoil in the papacy known as the *Great Schism.*

The Great Schism lasted from 1378 to 1417. During this time, candidates from Avignon and Rome both claimed to be the rightful pope. In 1409, the Council of Pisa tried to untangle the dispute but instead created a third claim to the office. Finally, the Council of Constance resolved the conflict in 1417. One man *abdicated* (resigned) and the two other candidates were deposed. A new pope, Martin V (1417-1431), was elected in their place as the single legitimate pontiff.

**Renaissance and Reformation.** The Renaissance was a European cultural movement that began in Italy during the early 1300's and spread throughout western Europe over the next 200 years. It stimulated perhaps the most powerful social force of modern times, the spirit of nationalism. This spirit showed itself in national antipapal attitudes in France and England. Taking advantage of such attitudes, the French and English kings forced the papacy to grant to royalty sizable shares of church taxes and property. The slow loss of church funds resulted in a loss of papal power, which was transferred to secular rulers. National churches in England and France developed as rivals to the international church ruled by the pope.

Many Renaissance popes were sophisticated Italian princes who came from prominent Italian families like the Borgias and the Medicis. Many were educated as diplomats, secular scholars, or patrons of the arts, but not as religious leaders.

A number of Renaissance popes were notable for their questionable moral character. Popes from the Italian nobility often combined worldly attention to the arts with promoting their powerful families. Pope Sixtus IV (1471-1484) was a patron of the arts and scholarship. He also made two of his nephews cardinals. One of them

**John XXIII,** a popular modern pope, called Vatican Council II, which reshaped much of church life.

**Paul VI** created much controversy with a 1968 encyclical that continued church teachings prohibiting birth control.

**John Paul II,** who was born in Poland, in 1978 became the first non-Italian pope since Adrian VI of the Netherlands.

became Pope Julius II (1503-1513). Julius II appeared interested in reform. He was a shrewd administrator and supported the work of the famous artists Raphael and Michelangelo. However, Julius was more concerned with political and military affairs than with the religious life of the church. He achieved no significant reform and did nothing to improve the papacy's moral image.

Toward the end of the Renaissance, several popes did attempt internal reforms. By this time the church was facing the threat of the Protestant Reformation, a movement that had swept through large parts of Europe. The Protestants did not accept the authority of the pope, and they broke away from the Catholic Church. A Catholic renewal movement known as the Counter Reformation, or Catholic Reformation, developed in the 1500's and 1600's. Pope Paul III (1534-1549) called the Council of Trent, which met periodically from 1545 to 1563. At the council, bishops struggled to reform church practices as well as to define Catholic belief. Paul III also formally approved the Society of Jesus (known as the Jesuits), a religious order established in 1534. The Jesuits became an influential group whose members pledged their loyalty directly to the pope.

Church efforts at reform extended through the Thirty Years' War (1618-1648) in Europe. According to the Peace of Westphalia that ended the war, a ruler's religion would determine the religion of the ruled area. This principle, which reflected the nationalism that was dominating Europe, further reduced the influence of the papacy, especially in Protestant Germany. By the mid-1600's, rulers of the new nation-states were viewing their power in absolute terms and challenging any papal claims to that power.

**The 1700's and 1800's.** During the 1700's, the papacy came under attack from several sides. A movement within the German church called *Febronianism* tried to limit claims to papal power. A similar doctrine, called *Josephism,* was put into practice by the Holy Roman Emperor. In France, the *Gallicanism* movement had similar goals. At the same time, Voltaire and other French thinkers called the *philosophes* were strongly opposed to Christian churches. Their thinking influenced popular opinion against organized religion and the Roman Catholic Church in particular.

Pope Benedict XIV (1740-1758), was probably the most admired pontiff of the 1700's. He gained respect from both Protestants and Catholics for his enlightened reign. Benedict was a skilful administrator and tried to strengthen the moral influence of the papacy. He encouraged education and founded academies for the study of Christian and Roman history.

During much of the 1800's, the popes joined with conservative political forces who were ruling Europe. These forces supported the church because of its long tradition as a stabilizing social influence. Its conservative alliances put the papacy into further opposition with European liberals, who were often antipapal. The liberals claimed that the church was blocking scientific and political progress.

Pope Pius IX (1846-1878) ruled longer than any pope in history. Pius originally had been a liberal who favoured unification of territories like the Italian states. But continued threats to papal power from Italian nationalists turned him into a strong conservative. In his *Syllabus of Errors* (1864), he condemned what he believed were errors of modern thought, including liberalism, rationalism, communism, and socialism. By 1870, all of the land that had once made up the Papal States was part of the independent kingdom of Italy. The pope's territory was reduced to the Vatican and Lateran palaces and the papal villa at Castel Gandolfo. Pius shut himself inside the Vatican and considered himself a prisoner. His successors followed the same policy for nearly 60 years, until the Lateran Treaty created the independent state of Vatican City in 1929.

As the political power of the popes decreased, their display of authority within the church grew stronger. The papacy presented itself as guardian of a clearly defined system of beliefs, opposed to Protestantism and the main currents of modern thought.

### The popes

| Name | Start of reign |
|---|---|
| *St. Peter (the Apostle) | Unknown |
| St. Linus | A.D. c. 67 |
| St. Anacletus (Cletus) | c. 76 |
| *St. Clement I | c. 92 |
| St. Evaristus | c. 101 |
| St. Alexander I | c. 105 |
| St. Sixtus I | c. 115 |
| St. Telesphorus | c. 125 |
| St. Hyginus | c. 136 |
| St. Pius I | c. 140 |
| St. Anicetus | c. 155 |
| St. Soter | c. 166 |
| St. Eleutherius | c. 175 |
| St. Victor I | 189 |
| St. Zephyrinus | 199 |
| St. Callistus I | 217 |
| *St. Hippolytus* | 217 |
| St. Urban I | 222 |
| St. Pontianus | 230 |
| St. Anterus | 235 |
| St. Fabian | 236 |
| St. Cornelius | 251 |
| *Novatian* | 251 |
| St. Lucius I | 253 |
| St. Stephen I | 254 |
| St. Sixtus II | 257 |
| St. Dionysius | 259 |
| St. Felix I | 269 |
| St. Eutychian | 275 |
| St. Caius | 283 |
| St. Marcellinus | 296 |
| (See vacant about 4 years.) | |
| St. Marcellus I | 308 |
| St. Eusebius | 309 |
| St. Melchiades or Miltiades | 311 |
| *St. Sylvester I | 314 |
| St. Marcus | 336 |
| St. Julius I | 337 |
| Liberius | 352 |
| *Felix II* | 355 |
| St. Damasus I | 366 |
| *Ursinus* | 366 |
| St. Siricius | 384 |
| St. Anastasius I | 399 |
| St. Innocent I | 401 |
| St. Zosimus | 417 |
| St. Boniface I | 418 |
| *Eulalius* | 418 |
| St. Celestine I | 422 |
| St. Sixtus III | 432 |
| *St. Leo I, the Great | 440 |
| St. Hilary | 461 |
| St. Simplicius | 468 |
| †St. Felix III (II) | 483 |
| St. Gelasius I | 492 |
| Anastasius II | 496 |
| St. Symmachus | 498 |
| *Lawrence* | 498; 501 |
| St. Hormisdas | 514 |
| St. John I | 523 |
| †St. Felix IV (III) | 526 |
| Boniface II | 530 |
| *Dioscorus* | 530 |
| John II | 533 |
| St. Agapitus I | 535 |
| St. Silverius | 536 |
| Vigilius | 537 |
| Pelagius I | 556 |
| John III | 561 |
| Benedict I | 575 |
| Pelagius II | 579 |
| *St. Gregory I, the Great | 590 |
| Sabinian | 604 |
| Boniface III | 607 |
| St. Boniface IV | 608 |
| St. Deusdedit or Adeodatus I | 615 |
| Boniface V | 619 |
| Honorius I | 625 |
| (See vacant 1 year and 7 months.) | |
| Severinus | 640 |
| John IV | 640 |
| Theodore I | 642 |
| St. Martin I | 649 |
| St. Eugene I | 654 |
| St. Vitalian | 657 |
| Adeodatus II | 672 |
| Donus | 676 |
| St. Agatho | 678 |
| St. Leo II | 682 |
| St. Benedict II | 684 |
| John V | 685 |
| Conon | 686 |
| *Theodore* | 687 |
| *Paschal* | 687 |
| St. Sergius I | 687 |
| John VI | 701 |
| John VII | 705 |
| Sisinnius | 708 |
| Constantine I | 708 |
| St. Gregory II | 715 |
| St. Gregory III | 731 |
| St. Zachary | 741 |
| ‡Stephen II (III) | 752 |
| St. Paul I | 757 |
| *Constantine* | 767 |
| *Philip* | 768 |
| ‡Stephen III (IV) | 768 |
| Adrian I | 772 |
| *St. Leo III | 795 |
| ‡Stephen IV (V) | 816 |
| St. Paschal I | 817 |
| Eugene II | 824 |
| Valentine | 827 |
| Gregory IV | 827 |
| *John* | 844 |
| Sergius II | 844 |
| St. Leo IV | 847 |
| Benedict III | 855 |
| *Anastasius* | 855 |
| St. Nicholas I | 858 |
| Adrian II | 867 |
| John VIII | 872 |
| Marinus I | 882 |
| St. Adrian III | 884 |
| ‡Stephen V (VI) | 885 |
| Formosus | 891 |
| Boniface VI | 896 |
| ‡Stephen VI (VII) | 896 |
| Romanus | 897 |
| Theodore II | 897 |
| John IX | 898 |
| Benedict IV | 900 |
| Leo V | [illegible] |
| *Christopher* | 903 |
| Sergius III | 904 |
| Anastasius III | 911 |
| Lando | 913 |
| John X | 914 |
| Leo VI | 928 |
| ‡Stephen VII (VIII) | 928 |
| John XI | 931 |
| Leo VII | 936 |
| ‡Stephen VIII (IX) | 939 |
| Marinus II | 942 |
| Agapitus II | 946 |
| John XII | 955 |
| Leo VIII | 963 |
| Benedict V | 964 |
| John XIII | 965 |
| Benedict VI | 973 |
| *Boniface VII* | 974 |
| Benedict VII | 974 |
| John XIV | 983 |
| John XV | 985 |
| Gregory V | 996 |
| *John XVI* | 997 |
| *Sylvester II | 999 |
| John XVII | 1003 |
| John XVIII | 1004 |
| Sergius IV | 1009 |
| Benedict VIII | 1012 |
| *Gregory* | 1012 |
| John XIX | 1024 |
| Benedict IX | 1032 |
| Sylvester III | 1045 |
| Benedict IX (2nd time) | 1045 |
| Gregory VI | 1045 |
| Clement II | 1046 |
| Benedict IX (3rd time) | 1047 |
| Damasus II | 1048 |
| *St. Leo IX | 1049 |
| Victor II | 1055 |
| ‡Stephen IX (X) | 1057 |
| *Benedict X* | 1058 |
| *Nicholas II | 1059 |
| Alexander II | 1061 |
| *Honorius II* | 1061 |
| *St. Gregory VII | 1073 |
| *Clement III* | 1080 |
| (See vacant 1 year.) | |
| Victor III | 1086 |
| *Urban II | 1088 |
| *Paschal II | 1099 |
| *Theodoric* | 1100 |
| *Albert* | 1102 |
| *Sylvester IV* | 1105 |
| Gelasius II | 1118 |
| *Gregory VIII* | 1118 |
| Calistus II | 1119 |
| Honorius II | 1124 |
| *Celestine II* | 1124 |
| Innocent II | 1130 |
| *Anacletus II* | 1130 |
| *Victor IV* | 1138 |
| Celestine II | 1143 |
| Lucius II | 1144 |
| *Eugene III | 1145 |
| Anastasius IV | 1153 |
| *Adrian IV | 1154 |
| *Alexander III | 1159 |
| *Victor IV* | 1159 |
| *Paschal III* | 1164 |
| *Calistus III* | 1168 |
| *Innocent III* | 1179 |
| Lucius III | 1181 |
| Urban III | 1185 |
| Gregory VIII | 1187 |
| Clement III | 1187 |
| Celestine III | 1191 |
| *Innocent III | 1198 |
| *Honorius III | 1216 |
| *Gregory IX | 1227 |
| Celestine IV | 1241 |
| (See vacant 1 year and 8 months.) | |
| *Innocent IV | 1243 |
| Alexander IV | 1254 |
| Urban IV | 1261 |
| Clement IV | 1265 |
| (See vacant 2 years and 9 months.) | |
| *Gregory X | 1271 |
| Innocent V | 1276 |
| Adrian V | 1276 |
| John XXI | 1276 |
| Nicholas III | 1277 |
| Martin IV | 1281 |
| Honorius IV | 1285 |
| Nicholas IV | 1288 |
| (See vacant 2 years and 3 months.) | |
| St. Celestine V | 1294 |
| *Boniface VIII | 1294 |
| Benedict XI | 1303 |
| Clement V | 1305 |
| (See vacant 1 year and 3 months.) | |
| *John XXII | 1316 |
| *Nicholas V at Rome* | 1328 |
| Benedict XII | 1334 |
| Clement VI | 1342 |
| Innocent VI | 1352 |
| Urban V | 1362 |
| Gregory XI | 1370 |
| *Urban VI | 1378 |
| Boniface IX | 1389 |
| Innocent VII | 1404 |
| Gregory XII | 1406 |
| **Clement VII* | 1378 |
| *Benedict XIII* | 1394 |
| *Alexander V* | 1409 |
| **John XXIII* | 1410 |
| *Martin V | 1417 |
| *Eugene IV | 1431 |
| *†Felix V (IV)* | 1439 |
| *Nicholas V | 1447 |
| Calistus III | 1455 |
| Pius II | 1458 |
| Paul II | 1464 |
| *Sixtus IV | 1471 |
| Innocent VIII | 1484 |
| *Alexander VI | 1492 |
| Pius III | 1503 |
| *Julius II | 1503 |
| *Leo X | 1513 |
| Adrian VI | 1522 |
| *Clement VII | 1523 |
| *Paul III | 1534 |
| Julius III | 1550 |
| Marcellus II | 1555 |
| *Paul IV | 1555 |
| *Pius IV | 1559 |
| *St. Pius V | 1566 |
| *Gregory XIII | 1572 |
| *Sixtus V | 1585 |
| Urban VII | 1590 |
| Gregory XIV | 1590 |
| Innocent IX | 1591 |
| *Clement VIII | 1592 |
| Leo XI | 1605 |
| Paul V | 1605 |
| Gregory XV | 1621 |
| Urban VIII | 1623 |
| Innocent X | 1644 |
| Alexander VII | 1655 |
| Clement IX | 1667 |
| Clement X | 1670 |
| Innocent XI | 1676 |
| Alexander VIII | 1689 |
| Innocent XII | 1691 |
| Clement XI | 1700 |
| Innocent XIII | 1721 |
| Benedict XIII | 1724 |
| Clement XII | 1730 |
| Benedict XIV | 1740 |
| Clement XIII | 1758 |
| Clement XIV | 1769 |
| Pius VI | 1775 |
| *Pius VII | 1800 |
| Leo XII | 1823 |
| Pius VIII | 1829 |
| Gregory XVI | 1831 |
| *Pius IX | [illegible] |
| *Leo XIII | 1878 |
| *St. Pius X | 1903 |
| *Benedict XV | 1914 |
| *Pius XI | 1922 |
| *Pius XII | 1939 |
| *John XXIII | 1958 |
| *Paul VI | 1963 |
| *John Paul I | 1978 |
| *John Paul II | 1978 |

Antipopes in *italics*.
Sources: *Catholic Almanac* and *New Catholic Encyclopedia*.
*Has a biography in *World Book*.

†An error in numbering occurred when another St. Felix was mistakenly included as a pope in some earlier lists. Popes St. Felix III and IV and antipope Felix V should each be moved up.
‡In 1961, the church dropped Stephen II, who died in 752, from the list of popes. The numbers of the others named Stephen were moved up.

**The papacy today.** The popes of the 1900's have been extremely active teaching church doctrines and morals. Their *encyclicals* (pastoral letters) have influenced Catholic thinking on a wide range of issues. These issues include social justice, family life, the value of the sciences, and the legitimacy of other faiths. At the same time Catholic thought has come into greater harmony with major intellectual developments, especially in such fields as philosophy, the natural sciences, history, and Biblical studies.

John XXIII (1958-1963) became one of the most popular of all modern popes. He called Vatican Council II to provide a renewal and updating of Catholic religious life and doctrine. The council opened in 1962 and ended in 1965, after John's death. One of the council's most challenging themes was *collegiality,* the idea that authority in the church is shared by the pope and a consensus of bishops and other clergy. John's successor, Paul VI (1963-1978), presided over the final years of the council. He withdrew controversial questions of celibacy and birth control from the council and reserved action on these topics to himself.

In 1978, John Paul II was elected the first non-Italian pope since Adrian VI (1522-1523) of the Netherlands. John Paul established himself as one of the most active popes in church history. He has travelled more and been seen by more people around the world than any previous pontiff.

Willingness to deal with important social and political issues has helped increase the prestige of the papacy. But confronting these issues has also created tensions between liberals and conservatives within the church. Some of these tensions centre on sensitive social topics, such as abortion and divorce. Others concern relations between the Holy See and members of the Roman Catholic Church as well as relations with other Christian churches and non-Christian religions.

**Related articles** in *World Book.* See the separate biographies of popes listed with asterisks in the *table* with this article. See also:

| | | |
|---|---|---|
| Bishop | Encyclical | Saint Peter's Church |
| Bull | Papal States | Swiss Guard |
| Cardinal | Pisa, Council of | Vatican City |
| Christianity | Reformation | Vatican Council |
| Counter Reformation | Roman Catholic Church | |

**Outline**

**I. The powers of the pope**
**II. Titles, clothing, and symbols**
**III. The daily life of the pope**
**IV. The election of a pope**
A. Early days
B. Present procedures
**V. History**

**Questions**

According to church doctrine, when is the pope *infallible?*
Where does the pope live during the summer?
Who can elect a new pope? How many votes are needed?
What Biblical passage do Roman Catholics cite as authority for the office of pope?
What was the importance of the reign of Pope Saint Gregory I?
What was the Babylonian Captivity? The Great Schism?
How is the pope addressed?
Who was the first pope?
What sensitive social and religious issues face the papacy?
What was the significance of Gallicanism, Febronianism, and Josephism?

**Pope, Alexander** (1688-1744), was the greatest English poet of the early 1700's. His brilliant verse satires ridiculed many kinds of human follies. Pope's biting wit made him one of the most feared writers of his time in England.

Pope wrote in heroic couplets, consisting of two rhymed lines of 10 syllables each. His verse is polished and concise, and shows a keen feeling for sound and rhythm. Pope has become one of the most quotable poets. He wrote many famous lines, including a couplet from *An Essay on Criticism* that expressed his literary creed:

> True wit is Nature to advantage dress'd,
> What oft was thought, but ne'er so well express'd.

Pope's career can be divided into three periods. During the first period, from about 1709 to 1715, he wrote *An Essay on Criticism* (1711). This witty poem about criticism and writing made him famous at the age of 23. It includes two famous lines: "A little learning is a dangerous thing" and "To err is human, to forgive divine." Pope's *The Rape of the Lock* (1712, 1714) is the most famous mock-epic poem in the English language. In the poem, Pope satirizes the vanities of fashionable people. *The Rape of the Lock* tells about a pretty young woman whose lock of hair is snipped off by a suitor at a party. Then a "battle of the sexes" follows, and Pope states his moral:

> Oh! if to dance all night, and dress all day
> Charm'd the smallpox, or chased old age away,
> Who would not scorn what housewife's cares produce,
> Or who would learn one earthly thing of use?

During the second period, from 1715 to 1726, Pope devoted himself to translating and editing. His translation of the Greek epic poem the *Iliad* (1715-1720) made him financially independent. With the profits, Pope bought a villa at Twickenham, near London, in 1719, and spent most of his remaining years there writing.

During the last period, Pope wrote his most serious satires. They express his belief in the value of common sense, a moral life, friendship, poetry, and good taste. *An Essay on Man* (1733-1734) is a long, ironic, philosophical poem. It includes the well-known line, "Hope springs eternal in the human breast." Pope's four *Moral Essays* (1731-1735) are satirical poems in the form of letters. One of these poems lightly exposes the follies that Pope saw in women, and another ridicules people who misuse wealth. *Imitations of Horace* (1733-1738) is patterned after the famous verse *epistles* (letters) and satires of the Roman poet Horace. It is prefaced by "An Epistle to Dr. Arbuthnot" (1735). In this pleasant satire, Pope created a favourable picture of the poet as a man who is independent, good, and a lover of truth. The poem also attacks Pope's enemies, especially the author Joseph Addison.

Pope's last major work was *The Dunciad* (1728-1743), an attack on dunces. The poem ridicules dull writers, biased critics, overly scholarly professors, and stupid scientists. Pope particularly ridiculed the critic Lewis Theobald and the writer Colley Cibber.

Pope was born in London. At the age of 12, he suffered a tubercular spinal infection. As a result of this illness, he grew to an adult height of only about 140 centi-

metres and developed a hunchback. Pope was extremely sensitive about his appearance.

See also **English literature** (The Augustan Age [Swift and Pope]).

**Popish Plot** (1678) was a fictional Roman Catholic conspiracy invented by two Englishmen, Titus Oates and Israel Tonge (see **Oates, Titus**). Oates and Tonge spread a rumour that there was a Jesuit plot to assassinate Charles II and replace him with his Roman Catholic brother James, Duke of York. Many English people feared that the Catholic Church was becoming too influential. Oates's story appeared to be confirmed when Sir Edmund Godfrey was found murdered, because Godfrey had been one of the first to be told of the plot. About 35 innocent people were tried and executed for treason following the panic started by Oates and Tonge. By 1682, Oates had been discredited. But his lies increased hostility to Roman Catholicism and to the Jesuits. The heightened feelings brought on by Oates's story caused Parliament to pass the Test Act in 1678, excluding Roman Catholics from the country's political life.

**Poplar** is any one of a group of fast-growing trees that are found throughout the Northern Hemisphere. Aspens and cottonwoods are poplars. These trees have pointed leaves with wavy, toothed edges. Many kinds of poplars have such flat leafstalks that even a slight breeze will cause the leaves to flutter. Early in the spring, before the leaves appear, small greenish flowers form in drooping clusters called *catkins*. Tiny seeds are hidden in fluffy, cottony hairs that make it easy for the wind to carry them through the air.

Poplars grow best in moist places. They grow easily from *cuttings* (cut twigs). People often plant poplars for shade because they grow fast. But poplars do not live long, seldom more than 100 years. The trees roots, in searching for water, tend to clog underground drainpipes and sewers. For this reason, it is illegal in some countries to plant poplars along city streets.

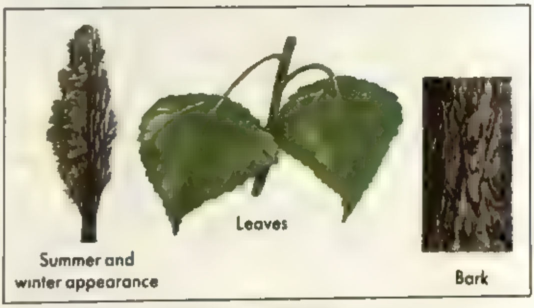
Poplar wood is whitish or light brown. The wood is also soft, light, and weak. Manufacturers use it to make boxes, crates, and matches. Paper-makers use it to make paper pulp and *excelsior* (wood shavings, used for stuffing furniture and packing breakable objects).

The *white poplar* has leaves that are silvery white beneath and have three or five lobes. The bark on the branches is white. The *Lombardy poplar* is tall and narrow and has diamond-shaped leaves. Its branches point upwards. The white and Lombardy poplars are native to Europe and have been introduced to other countries. In the past, people often planted these poplars in rows in formal gardens, for roadside landscaping, and to shelter other plants from the wind. However, their popularity as landscape trees has declined because they are easily damaged by insects, wind, and disease. These trees do not produce seeds.

The *Carolina poplar* is a hybrid derived from the American eastern cottonwood and the European black poplar (see **Hybrid**). This type of poplar has triangular leaves. The tree probably originated in France in about 1750. It can endure city smoke and dust and grows well in large cities. All Carolina poplars are male and do not produce the cottony seeds found in other varieties.

*Balsam poplar*, or *tacamahac*, is widely distributed across Canada. It lives as far north as trees will grow and south to the northern United States. The sticky buds and young leaves have an odour of balsam. Honeybees use the fragrant gummy substance to waterproof their hives. *Balm of Gilead* is a cultivated variety with heart-shaped leaves.

**Tall, graceful Lombardy poplars** are sometimes used in roadside landscaping. The tree is native to Europe.




**The balsam poplar** grows in Canada and the northern United States. Its buds and young leaves have a fragrance of balsam.

**Scientific classification.** Poplars belong to the willow family Salicaceae. The white poplar is *Populus alba*, the Lombardy poplar is *P. nigra*, the Carolina poplar is *P. canadensis*, and the balsam poplar is *P. balsamifera*.

See also **Aspen; Balm of Gilead; Cottonwood.**

**Popocatépetl** is a volcanic mountain that lies about 64 kilometres southeast of Mexico City. For its location, see **Mexico** (physical map).

Popocatépetl is one of the highest peaks in North America. Its altitude (5,452 metres) is only 742 metres less than that of Mount McKinley, the highest peak on the continent. Its Aztec name means *smoking mountain*. Popocatépetl is often called simply "Popo."

The top of Popocatépetl is always covered with snow. Banana, palm, and orange trees grow at its base. Popocatépetl has not erupted violently for many years. However, clouds of smoke and gas, and sometimes stones and ashes, pour from it. A small eruption of ash took place in 1943. The last major eruption of Popocatépetl occurred in 1702. Sulphur inside the summit crater has

been mined at times, although transportation is difficult in the region.

The mountain can be climbed fairly easily. A member of Hernando Cortés' group which conquered Mexico in the 1520's was probably the first white person to climb it.

**Poppy** is the common name for several related groups of flowers. The most important member is the white, pink, red, or purple opium poppy of China, India, and Iran. It has been raised in Asia since ancient times.

The flowers of poppies are admired for their delicate beauty and gracefulness. Breeders have produced many variations in the size and form of the blossom. Most kinds are hardy and easy to cultivate. The tiny seeds have no narcotic properties, and are sold for bird food. They also yield an oil used in preparing some foods for human consumption. The oil cake remaining is a valuable cattle food. Poppy seeds are also used as flavouring. Poppy seeds may be sprinkled on bread and rolls, or used in filling for cakes.

The *common* or *corn poppy* grows wild in the grain fields and grassy meadows of Europe. Many varieties of the common poppy are grown from seed in flower gardens. The *Iceland poppy* is widely cultivated in gardens. Its long-lasting flowers are various shades of white, orange, yellow, rose-pink, and scarlet. The most showy poppy is the large-flowered *Oriental poppy.* Its red, orange, white, or salmon-coloured flowers often have blackish-purple centres. The *California poppy* grows wild in the western United States, and is cultivated elsewhere.

Many poppies are annual plants that can be grown from seed. But the Oriental poppy is a perennial, and is best transplanted by root sections. The poppy flowers in summer.

Opium comes from the young capsules of the opium poppy where the seeds develop. To obtain it, workers scratch the capsules late in the day. The milky juice that seeps out solidifies overnight, and is collected the next day. It takes 120,000 capsules to yield about 10 to 18 kilograms of opium.

**Poppies grow from seed in flower gardens.**

**Scientific classification.** Poppies belong to the poppy family, Papaveraceae. The opium poppy is *Papaver somniferum,* the common poppy is *P. rhoeas,* the Iceland poppy is *P. nudicaule,* the Oriental poppy is *P. orientale,* and the California poppy is *Eschscholtzia californica.*

See also **Celandine; Flower** (pictures: Garden perennials; Flowers of the arctic tundra), **Opium.**

**Poppy Day.** See **Remembrance Day.**

**Popular music** is music that has mass appeal—that is, music that is enjoyed by a very large proportion of the population. The term is often used to distinguish such music from classical music. Classical music is a studied art form in which more or less complicated compositions are performed by solo instrumentalists, string quartets, symphony orchestras, and so on. Some people feel that popular music is simple and entertaining, while classical music is serious, refined, or difficult to appreciate. But popular songs, such as John Lennon and Paul McCartney's "Eleanor Rigby," are serious and quite complex, and many classical works, such as Mozart's *Eine Kleine Nachtmusik,* the symphonies of Tchaikovsky, or Ravel's *Bolero,* are known and enjoyed by millions. Some classical pieces, such as several of Chopin's piano works, have even been adapted as popular songs.

Today, the term "popular music" covers such diverse styles as American country and western music, jazz, music from musical comedies and other stage shows, film music, and various styles such as rock, soul, and reggae, which together form modern *pop* music.

Every period in history had its own form of popular music. In the 1900's, popular music achieved great social and economic importance, largely through developments in sound recording and broadcasting. Today, it ranks as a major industry in Europe, North America, and Australia. The booming musical film industry in India has also helped the development of a specifically Indian form of popular music.

## Characteristics of popular music

Most popular music consists of songs that have a strong, memorable melody and suitable words. The words of popular songs are known as *lyrics.* These songs cover a wide range of subjects. A large number describe the joys and heartaches of being in love. Many songs protest against social injustices or illustrate a mood. Some songs comment wittily, movingly, or angrily upon events of the day. Others reflect dances, fads, fashions, and games.

Popular songs may be social documents that reflect a nation's history. But a major purpose of most popular music is to entertain. Much instrumental music is written for dancing. "In the Mood" and "Moonlight Serenade," by the famous U.S. bandleader of the 1930's and 1940's, Glenn Miller, and the 1960's hit "Green Onions," by Booker T. and the M.G.s, are among popular instrumental numbers of the 1900's.

## The development of popular music

Many experts consider that the authorship and date of folk songs is usually unknown, but popular music is normally the work of a known composer using the musical style of his or her time, or else it is a piece of music that appears at a particular point in time and reflects a particular historical event, fashion, or dance craze. The

famous song "Greensleeves" appeared in the early 1500's. It was once thought that King Henry VIII had written it. A tune published in a book of melodies for pipe or recorder in 1686 was used for "Liliburlero," a savagely satirical song that appeared in 1687 in protest at the appointment of General Richard Talbot as Lord Lieutenant of Ireland.

The pilgrim settlers who sailed to America in the 1600's took with them many popular songs, especially psalms. *The Bay Psalm Book* (1640), a book of psalms with directions on how to sing them, was the first book ever published in America. In the late 1700's, British troops fighting American colonists during the American Revolution made up a song called "Yankee Doodle," mocking their opponents. This was the first successful popular song in America.

In the early 1800's, people began to identify popular musical items with individual performers. The British clown Joseph Grimaldi used to end his act with a jokey song called "Hot Codlins," which became widely popular. In the later 1800's and early 1900's, music-hall stars such as Marie Lloyd, Nellie Wallace, and later Sir Harry Lauder and George Formby all became associated with certain songs and made them famous.

In the 1800's, many people in Britain enjoyed playing the piano at home, and parlour songs such as the Irish composer Michael Balfe's "Come into the garden, Maud," with lyrics by Alfred Tennyson, were very popular. The U.S. composer Stephen Collins Foster left a wealth of popular songs that won international fame. They include "Beautiful Dreamer," "Old Folks at Home," and "Jeanie with the Light Brown Hair." One of Foster's songs, "Dixie," was the campaign song of the Confederate forces in the American Civil War (1861-1865). The soldiers of the Union marched to the "Battle Hymn of the Republic."

Negro spirituals sung by the black American slaves before the Civil War gained great popularity. After the war, minstrel shows, in which white performers wore black face makeup to resemble blacks, promoted an unrealistic view of Afro-American life. Many of Stephen Foster's songs (such as "The Camptown Races") were sung in minstrel shows, which drew large crowds both within and outside the United States. Cowboy songs, such as "Home on the Range," composed in the 1870's, were very popular.

**The 1900's.** Many factors influenced the development of popular music in the 1900's. These factors include the start of electric recording and radio broadcasting, the birth of the "talkies" (films with sound), and the massive growth in the publishing of cheap sheet music, all during the 1920's. The music publishing industry became known as *Tin Pan Alley.* This was a nickname for 28th Street, New York City, where many music publishers had their offices. The same name was also applied to Denmark Street, in London, for the same reason.

The two world wars provided their own crop of popular songs. In World War I (1914-1918), British soldiers marched to "It's a Long Way to Tipperary" or "Pack Up Your Troubles." U.S. soldiers sang "Over There." In World War II (1939-1945), sentimental ballads such as "We'll Meet Again" and up-tempo big band numbers such as "Don't Sit Under the Apple Tree" were among very many songs that gained wide appeal through broadcasts to the Allied Forces. One Song, "Lilli Marlene," was originally picked up from a broadcast by German radio. It became a favourite with both German and Allied troops.

In the 1900's, popular music of the United States exerted a great influence over that of other countries. In the 1920's, the first American singing stars began to emerge. Bing Crosby, probably the most famous of them, had a career that lasted 50 years before his death in 1977. Later singers were Nat "King" Cole and Frank Sinatra. Jazz, the single most important influence on popular music in the 1900's, produced such artists as Louis Armstrong and Ella Fitzgerald.

The 1930's and 1940's were the era of the big bands (see **Band**). In the U.S., famous bandleaders included the pianists Count Basie and Duke Ellington and the clarinettist Benny Goodman. In Britain, bands led by Henry Hall, Joe Loss, Geraldo, and Ambrose were loved by millions. The 1940's were dominated by the music of U.S. bandleader Glenn Miller.

The 1900's saw the rise of musical comedy, a form of stage show or film in which the plot is held together by songs and dances punctuating the spoken dialogue. Song-writers such as Irving Berlin, George and Ira Gershwin, Richard Rodgers (working with Lorenz Hart and later with Oscar Hammerstein II), Leonard Bernstein, and Stephen Sondheim were major contributors to the stock of music and songs in this field. British composers of musicals include Noël Coward, whose clever musical plays packed British theatres in the 1930's, and Andrew Lloyd Webber, whose musical show *Cats* was one of the most successful stage productions of all time.

**Pop music** is the broad term used to describe the popular music enjoyed mainly by young people since the 1950's. The term *pop* also describes the changing youthful culture of which the music is an expression. Pop music includes such diverse styles as rhythm and blues, rock and roll, punk, heavy metal, disco, soul, hip-hop, house music, world music, and New Age. The oldest of these, rhythm and blues, has its roots in blues music of the southern United States. Rock and roll derived from rhythm and blues and a type of country music that was popular in the United States soon after World War II. The most famous and influential rock and roll star was the American Elvis Presley. He began his recording career in 1954 and made a string of hits (such as "Hound Dog" and "All Shook Up") and 33 films before his tragically early death in 1977. Other great rock and roll stars included Buddy Holly and Chuck Berry. The term "rock music" encompasses many types of popular music including rock and roll and heavy metal.

In the late 1950's, a musical style called *soul* started to develop. Evolving out of rhythm and blues, soul merged the gospel tradition of music with secular lyrics. Ray Charles was the first leading light in this field, followed by Sam Cooke and James Brown. The Atlantic, Stax, and Motown record companies developed the form through the 1960's with major artists such as Aretha Franklin, Otis Redding, and Stevie Wonder. Soul continues today, the style having expanded to include funk and dance music.

In the 1960's, the Beatles, four boys from Liverpool, England, became the most famous pop group in history. They used conventional pop group line-up of two elec-

tric guitars, bass guitar, and drums and had a long string of hits written by group members John Lennon and Paul McCartney that included "She Loves You," "Can't Buy Me Love," and the album *Sergeant Pepper's Lonely Hearts Club Band* (1967). The Beach Boys, the Rolling Stones, the Who, and the Jimi Hendrix Experience also were very popular. Bob Dylan won fame with his protest songs and his folk-rock music. Other artists included U.S. singer-songwriters Carole King, James Taylor, and Paul Simon and Art Garfunkel.

In the 1970's use of the electronic synthesizer brought new dimensions to pop music through such bands as Genesis and Pink Floyd. The film *Saturday Night Fever* led to the emergence of a type of undemanding dance music called disco. The *punk rock* and *new wave* movements popular in the mid- and late 1970's began partly as a backlash against the technical, impersonal sounds of disco. Throughout the 1970's as a whole, artists and groups such as Elton John, David Bowie, Led Zeppelin, Queen, and Abba (a group from Sweden) dominated.

The 1980's saw the rise of U.S. artists such as Bruce Springsteen and Madonna. But for many, the greatest pop star of the 1980's and early 1990's was Michael Jackson. Chief trends included the development of world music, in which music from African countries plays a prominent part. Paul Simon's album *Graceland* was a formative influence in this respect.

The rise of rap began in the 1980's. Growing out of black street culture in New York City, rap consists of words recited over a strong rhythm track. Many rap groups use the form to comment on such social problems as racism and poverty. Many performers whose careers began in the 1960's remain prominent in pop music today. Eric Clapton, Tina Turner, and Neil Young all began their careers in the 1960's.

Successful Australian pop artists have included Rolf Harris, Frank Ifield, the Seekers, and the Bee Gees, all from the 1960's, and Olivia Newton John from the 1970's. In the 1980's, artists such as AC/DC, Kylie Minogue, Jason Donovan, Men at Work, and Inxs won international acclaim.

**Related articles** in *World Book* include:

**Composers and lyricists**

Beatles
Berlin, Irving
Bernstein, Leonard
Bland, James A.
Carmichael, Hoagy
Cohan, George M.
Dylan, Bob
Ellington, Duke
Foster, Stephen C.
Friml, Rudolf
Gershwin, George
Guthrie, Woody
Hammerstein, Oscar, II
Hart, Lorenz
Herbert, Victor
Kern, Jerome
Lerner, Alan J.
Loesser, Frank
McKuen, Rod
Porter, Cole
Rodgers, Richard
Romberg, Sigmund
Sondheim, Stephen
Sousa, John Philip

**Singers**

Armstrong, Louis
Baez, Joan
Belafonte, Harry
Berry, Chuck
Crosby, Bing
Fitzgerald, Ella
Garland, Judy
Holiday, Billie
Holly, Buddy
Horne, Lena
Ives, Burl
Jackson, Mahalia
Jackson, Michael
Jolson, Al
Presley, Elvis
Rolling Stones
Seeger, Pete
Simon, Paul
Sinatra, Frank
Smith, Bessie
Springsteen, Bruce
Waters, Ethel
Who, The
Williams, Hank
Wonder, Stevie

**Songs**

Dixie
Star-Spangled Banner
Yankee Doodle

**Styles**

Calypso
Country music
Folk music
Jazz
Minstrel show
Musical comedy
Ragtime
Rock music

**Popular sovereignty** was a doctrine that developed during the controversy over slavery that is part of the history of the early United States. Also called *squatter sovereignty,* the doctrine held that the people of a territory could decide for themselves whether or not they wanted slavery, even before the territory became a state.

The North, as a whole, opposed extension of slavery into any of the land acquired from Mexico after the war with Mexico. The South, even more unanimously, favoured it. Many people on both sides found the theory of popular sovereignty a happy solution. It relieved both the states and the United States Congress of a difficult problem. Lewis Cass probably originated the theory of popular sovereignty, but Stephen A. Douglas, its most prominent advocate, was the first person to use the term *popular sovereignty.*

The Kansas-Nebraska Act of 1854 permitted the people of the Kansas and Nebraska territories to decide for or against slavery within their respective borders. The authors of the law took for granted that Nebraska would vote free, and Kansas, slave. But antislavery advocates sent many free-state settlers into Kansas, while many proslavery residents of Missouri crossed into Kansas, sometimes to settle, but often only to vote. The violence and bloodshed that resulted showed that the principle of popular sovereignty would not work. After the Civil War, when slavery was abolished, popular sovereignty lost its significance.

**Population** of a country or other area is the total number of people who live in it. Populations change as a result of migration and a process called *natural increase.* Natural increase is the difference between births and deaths. Most countries have more births than deaths, and so their population increases, unless a net loss results from migration.

## World population

The world population rose to about 5,812,000,000 in 1996. The number of people is increasing at an annual rate of 1.6 per cent. Scholars estimate that the world's population totalled about 550 million in 1650. The population of the world doubled in the period from 1650 to 1850 and has increased by nearly five times since 1850. See **World** (Population; diagram).

European populations in Europe and overseas increased rapidly in the 1700's as death rates dropped. But declines in birth rates reduced population growth and eventually led to a decrease in some countries. During the 1980's, European countries with decreasing populations included Hungary and West Germany.

In most of Asia, Africa, and Latin America, death rates declined rapidly during the middle decades of the 1900's. Longer life spans were brought about by the reduction of famines and epidemics, improved water supplies and sewage disposal, and better medical care.

The populations of continents show the effects of differing rates of both migration and natural increase. The past 300 years have been a period of several great migrations, including that of Europeans to the Americas and some Pacific areas.

Asia is the most populous continent, with about three-fifths of the world's population. The two countries with the largest populations are in Asia. They are China, which had 1,252,188,000 people in 1996, and India, with 947,803,000. The two next largest countries are the United States, with 264,015,000 people, and Indonesia, with 204,660,000. See the maps on population with the articles on states, provinces, regions, and continents.

**Urban and rural population.** Migration from rural areas to cities grew with industrialization in Western countries and Japan. Today, it is occurring in most countries, even in those that remain predominantly agricultural. In 1800, only about 5 per cent of the people of the United States lived in places with a population of 2,500 or more. Today, about 75 per cent live in places of that size or larger. In 1800, about 20 per cent of the population of England lived in cities. Today, 90 per cent live in cities.

**Census.** Most governments conduct *censuses* (regular counts of the population) to learn the numbers, the places of residence, and the characteristics of their peoples. Most countries in the world have taken at least one census in the last 10 years. Governments also collect information on birth and death rates, called *vital statistics.* The study of the size, distribution, and characteristics of populations, and of changes in population, is called *demography.* The United Nations helps countries improve their demographic information.

**Age.** A population growing rapidly because of a high birth rate usually has a high proportion of children. A slowly growing population usually has a low proportion of children. Current estimates for the population of the world indicate that about 32 per cent of the people are below 15 years of age. About 62 per cent of the people are between the ages of 15 and 64, and fewer than 6 per cent are over 64 years of age. In Kenya and other countries with high birth rates, about half the people are below 15 years of age.

In the United Kingdom (UK), about 20 per cent of the population are less than 16 years old, about 64 per cent are between 16 and 64, and about 16 per cent are 65 and over. In developing countries, the proportion of young people is higher than in industrial countries, where population growth is slower. In China, about 60 per cent of the population is under 29 years old; in India, about 65 per cent; and in the Philippines, about 70 per cent. The proportion of people in the UK under 29 is only about 40 per cent. In some African countries, about half the population are below 15 years of age, while only 3 per cent are over 64 years old.

Statistics on the proportions of various age groups help society prepare for more schoolchildren, workers, or aged people. The *dependency ratio* is a comparison of the number of children and elderly people with the number of people in the main working ages. This ratio is high if a large proportion of the population are dependents. Nations with a rapidly growing population have a high dependency ratio. The support of dependents places a burden on the workers of such countries, and many children and older adults may try to find work.

### Population growth

Population growth is most rapid in nations with high birth rates. Immigration also has an important effect on population growth and may alter the balance of sexes.

In Australia and New Zealand, population growth has generally been high since European settlement began—1788 in Australia and 1840 in New Zealand. Throughout the 1950's and 1960's, immigration accounted for half of Australia's population growth, and for about a third of New Zealand's population growth. Immigration declined in the 1970's, but later revived. However, the birth rate in both countries is low—about 15 for every thousand people. Both Australia and New Zealand are likely to have slow population growth during the 1990's. The population of Australia is likely to rise to 20 million by 2000, but only if immigration remains at the level of the 1980's.

The UK is about 20th in the world in terms of population, and has some of the most accurate statistics, about population growth. Every ten years since 1801, there have been censuses. The only gap was in 1941, when no census was taken because of World War II. In 1837, the registration of births, marriages, and deaths was made compulsory in the UK, and this helped make population statistics more accurate. The UK's population is growing slowly. From 57.1 million in 1989, it is expected to grow to 59 million in 2001, and to 59.4 million in 2011. There has been an increase in the proportion of elderly people. About 18 per cent of the population are over normal retirement age (65 for men and 60 for women), compared with 15 per cent in 1961. This pattern is also found in other European countries.

Developing nations make up over 75 per cent of the world's population. Between them, China and India have more than 37 per cent of the world's people. India has a birth rate of about 30 per thousand people. This is more than in China, where it is about 20 per thousand people. In recent years, China's government has followed a strict policy of birth control, limiting people to one child per family. In parts of Africa, birth rates are even higher than in India, at about 40 per thousand people.

The world's population grew more rapidly in the late 1980's than was projected. The United Nations had projected earlier in the decade that the world's population would increase each year by 1.6 per cent, but actual growth rates for the late 1980's averaged 1.7 per cent. The seemingly small difference in growth rate represents more than 5 million additional people per year. If growth continues at this rate, the world's population will

**World population and yearly growth**

| Major area | Population (1996 estimate) | Yearly growth (1996-2001) |
|---|---|---|
| World | 5,812,000,000 | 1.6% |
| Africa | 731,000,000 | 2.8 |
| Asia | 3,557,000,000 | 1.6 |
| Australia | 18,000,000 | 1.3 |
| Europe | 713,000,000 | 0.3 |
| North America | 458,000,000 | 0.9 |
| Pacific Islands (including New Zealand) | 13,000,000 | 1.7 |
| South America | 323,000,000 | 1.6 |

Source: *World Book* estimates based primarily on data from United Nations.

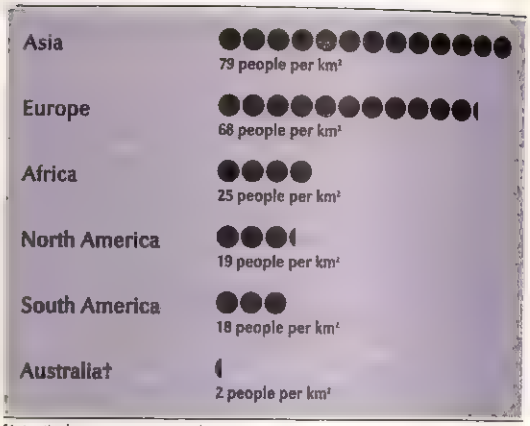
have doubled by 2028, several years earlier than had been projected.

**Regional growth rates.** The discrepancy between projected and actual growth rates may be due to higher than expected growth rates in the developing world. The overall growth rate for these nations was 2.1 per cent annually, indicating that their populations would double in 33 years. Two of the highest growth rates were reported in Kenya and the Gaza Strip (an area on the Mediterranean coast where Egypt and Israel meet).

In industrial nations, the overall growth rate was 0.6 per cent, a rate at which population doubles in 120 years. In several industrial countries—including Austria, Denmark, Germany, Hungary—the population did not increase at all, or even showed a decrease.

In Australia and New Zealand, the most rapidly growing segments of the population are the Aborigines, in Australia, and the Maori, in New Zealand. There are about 300,000 New Zealand Maori, compared with only 100,000 in 1945. There are about 200,000 Australian Aborigines. Their numbers grew rapidly during the 1980's, at an average rate of about 5 per cent. Australian government officials explained the rapid rise by the fact that many people identified themselves as Aborigines for the first time in the 1986 census.

**Population density of the continents***




*Antarctica has no permanent population.
†Australia figure includes the Pacific Islands.
Source: 1996 *World Book* estimates based primarily on data from United Nations.

### The population explosion

The rapid increase in the world's population has been called the *population explosion.*

**Causes.** For thousands of years, birth rates were high, but the population increased only slowly because death rates also were high. Then, during the 1700's and 1800's, advances in agriculture, communication, and transportation improved living conditions and reduced the occurrence of many diseases. As a result, the death rate began to drop, and the population grew rapidly.

In the industrial countries of Europe and North America, many people flocked to the cities and took jobs in factories. In cities and in many rural areas, it was difficult to support a large family. People began to see reasons for having smaller families. As a result, birth rates in these countries began to fall. In the agricultural countries of Africa, Asia, and Latin America, declines in death rates did not occur until the mid-1900's. Then death rates plunged quickly without corresponding declines in birth rates. As a result, the population of low-income nations and of the world increased rapidly.

**Effects.** Many scientists, economists, and other experts fear that food production cannot keep pace with the population for long. They believe the world already is or will soon become *overpopulated*—that is, it will have more people than it can support at an acceptable standard of living. This theory was put forth by the British economist Thomas Robert Malthus in the late 1700's. Malthus stated that population tends to increase beyond the limit of the earth's ability to support it. He predicted that famine, war, and other disasters would become common unless people cut the growth rate.

Many people dispute Malthus' views. They point out that since Malthus made his gloomy forecast, world population has grown by more than 4 billion. More people are living longer and healthier lives than ever before. Many experts believe it is technologically possible to increase world food production by more than 1.7 per cent yearly and thus to keep ahead of population growth. During the 1960's, for example, improved farming methods and new high-yield crop varieties helped many poor countries increase their food production by about 25 per cent. Some people believe that the problem is not too many people, as Malthus claimed there were, but too much inequality. They think that starvation and poverty could be overcome with a more equal distribution of existing resources.

**Population control.** Many experts worry that people in rich and poor countries alike consume too much, destroy forests and soil, pollute the environment, and damage prospects for human survival on earth. They believe disastrous shortages of food and other necessities can be avoided only by halting population growth. They urge that the birth rate be reduced to replacement level, an average of about 2.1 children per woman, so that only enough people are born to replace those who die. The resulting condition is called *zero population growth* or ZPG. In the United States and much of Europe, the birth rate is below replacement level. But in many of the world's poorer countries, women have an average of as many as 7 or 8 children.

The governments of many countries have tried to reduce the birth rate. China, for example, has persuaded millions of couples to have only one child. In many other countries, birth rates have declined more slowly and are still far above replacement level.

The decisions that women and men make about having children are influenced by many other factors besides government policies. These factors include their social and economic circumstances, their education, their need to have someone care for them in their old age, their feelings about the future, and their access to information and medical care. As a result, future social and economic changes will have important effects on birth rates and population growth.

**Related articles** in *World Book* include:

Birth and death rates
Birth control
Census
City (Population growth; Metropolitan cities)
Demography
Ehrlich, Paul
Food supply (Increased demand for food)
Immigration
Malthus, Thomas Robert
Races, Human
Vital statistics
World (tables; map)

**Populism** was an American political movement that attained its greatest strength during the 1890's. The Populists supported an increase in the money supply, greater government regulation of business, and other changes they believed would help farmers and labourers. In addition, they called for many reforms to increase the political power of voters. Many Populist leaders were colourful figures who stirred up the people with rousing speeches.

The word *populist* is used more generally to describe political policies like those of the Populists, especially policies that favour the common people.

**Origins.** Populism began among the farmers of the Midwest, South, and West of the United States. During the 1870's and 1880's, these farmers suffered from a combination of falling crop prices and rising operating costs. Railway freight rates and interest rates charged by lenders caused much resentment among farmers. To address these problems, groups of farmers formed *farmers' alliances.*

The farmers' alliances called for the government to put more money into circulation, either by printing more paper money or by coining unlimited amounts of silver. Such a coinage policy was called *free silver.* The farmers believed an increase in the money supply would help them get higher prices for their crops. The farmers also wanted the government to regulate the railways or take them over completely. These demands became the chief goals of the Populist movement.

**The People's Party.** In 1891, the farmers' alliances met with delegates from labour and reform groups in Cincinnati, Ohio, and discussed forming a new political party. These alliances and groups formed the People's Party, usually called the Populist Party, a year later in St. Louis, Missouri.

In 1892, the party nominated James B. Weaver of Iowa for president and James G. Field of Virginia for vice president. Their platform called for free silver, government ownership of railways and telegraph and telephone lines, and many political reforms. The candidates did not win, but they received more than a million popular votes and 22 electoral votes. Nine Populists were elected to the United States Congress.

In 1896, the Democratic Party nominated William Jennings Bryan of Nebraska for President. His platform included free silver and other Populist demands. The Populists joined the Democrats in supporting Bryan, but he lost to William McKinley, the candidate of the Republican Party. The People's Party started to decline, and it had disappeared by 1904.

**Influences of populism.** Although the People's Party faded away, many of its goals were adopted by the progressive movement and later became law (see **Progressive movement**). These goals included direct election of United States senators and the *initiative and referendum,* a process by which voters propose a law and vote on it. Other reforms supported by the Populists included a graduated income tax, which taxes higher incomes more heavily than lower ones, and an 8-hour working day.

Today, the word *populist* is often used to describe a U.S. politician who opposes party leaders and appeals directly to the public for support. Most of the so-called "new populists" come from rural areas, and traditional politicians regard them as outsiders. Many leaders with widely varying philosophies have been called populists. Since the 1960's, they have included President Jimmy Carter, Senator George S. McGovern of South Dakota, Governor George C. Wallace of Alabama, and Vice President Hubert H. Humphrey.

See also **Bryan, William Jennings; Donnelly, Ignatius; Free silver.**

**Poquelin, Jean Baptiste.** See Molière.

**Porcelain** is a type of ceramics highly valued for its beauty and strength. It is often called *china,* or *chinaware,* because it was first made in China. Porcelain is characterized by whiteness, a delicate appearance, and *translucence* (ability to let light through). Because it is the hardest ceramic product, porcelain is used for electrical insulators and laboratory equipment. However, porcelain is known primarily as a material for high-quality vases and tableware, as well as for figurines and other decorative objects. The type of porcelain used for such purposes produces a bell-like ring when struck.

Porcelain differs from other types of ceramics in its ingredients and in the process by which it is produced. Two common types of ceramics—earthenware and stoneware—are made from a single natural clay, which is then *fired* (baked). In many cases, the object is coated with a glassy substance called *glaze.* Firing at a low temperature produces earthenware, a porous material. Earthenware can be made waterproof by glazing. Firing at a high temperature produces stoneware, a hard, heavy material. Stoneware is nonporous without glazing.

Unlike earthenware and stoneware, porcelain is basically made from a mixture of two ingredients—*kaolin* and *petuntse.* Kaolin is a pure white clay that forms

Metropolitan Museum of Art, New York City

**A Chinese vase** features a deep blue *underglaze,* a design painted on the surface before the porcelain is glazed. This vase was made between 1426 and 1435, during the Ming dynasty.

when the mineral feldspar breaks down. Petuntse is a type of feldspar found only in China. It is ground to a fine powder and mixed with kaolin. This mixture is fired at temperatures from about 1250° C to 1450° C. At these extreme temperatures, the petuntse *vitrifies*—that is, it melts together and forms a nonporous, natural glass. The kaolin, which is highly resistant to heat, does not melt and therefore allows the item to hold its shape. The process is complete when the petuntse fuses itself to the kaolin.

### Kinds of porcelain

There are three main kinds of porcelain: (1) hard-paste porcelain, (2) soft-paste porcelain, and (3) bone china. The differences between these types of porcelain are based on the material from which they are made. This material is called the *body* or *paste*.

**Hard-paste porcelain,** sometimes called *true porcelain* or *natural porcelain,* has always been the model and ideal of porcelain makers. It is the type of porcelain first developed by the Chinese from kaolin and petuntse. Hard-paste porcelain resists melting far better than other kinds of porcelain, and so it can be fired at higher temperatures. These high temperatures cause the body and the glaze to become one. When hard-paste porcelain is broken, it is impossible to distinguish the body from the glaze.

The Metropolitan Museum of Art, New York City

**A Sèvres tray** made in 1767 shows the brilliant colours and gilding typical of this French porcelain. The white panel painted with birds in a landscape also became a common Sèvres design.

The proportions of kaolin and petuntse in hard-paste porcelain may vary. The porcelain is said to be *severe* if the percentage of kaolin is high, and *mild* if the percentage of kaolin is low. Most collectors of porcelain prefer mild porcelain because of its mellow, satiny appearance. In comparison, severe porcelain may seem harsh and cold.

**Soft-paste porcelain,** sometimes called *artificial porcelain,* was developed in Europe in an attempt to imitate Chinese hard-paste porcelain. Experimenters used a wide variety of materials in their efforts to produce a substance that was hard, white, and translucent. They eventually developed soft-paste porcelain by using mixtures of fine clay and glasslike substances. These materials melt at the high temperatures used in making hard-paste porcelain. For this reason, soft-paste porcelain is fired at lower temperatures and does not completely vitrify—that is, it remains somewhat porous. Breaking a piece of soft-paste porcelain reveals a grainy body covered with a glassy layer of glaze.

Although soft-paste porcelain was invented in imitation of true porcelain, it has merits of its own. Most of it is creamy in tone, and some people prefer this colour to pure white. In addition, the colours used to decorate it merge with the glaze to produce a soft, silky effect that appeals to many collectors.

**Bone china** is basically made by adding *bone ash* (burned animal bones) to kaolin and petuntse. English porcelain makers discovered this combination of ingredients in about 1750, and England still produces nearly all the world's bone china. Though not as hard as true porcelain, bone china is more durable than soft-paste porcelain. The bone ash greatly increases the translucence of the porcelain.

### Decorating porcelain

A piece of porcelain is shaped on a potter's wheel or in a mould. After this stage, the porcelain worker may decorate it by (1) surface modifications, (2) painting, or (3) transfer printing.

**Surface modifications** are achieved by *incising* (carving), *perforating* (poking holes), and *embossing* (applying raised designs). A well-known method of embossing porcelain is to apply a mixture of water and clay, called *slip,* to the item with a brush. *Relief designs* (three-dimensional effects) are usually moulded separately and then attached to the porcelain.

**Painting** the porcelain surface may be done in several ways. One method is to use a coloured glaze, such as the famous Chinese *celadon.* This glaze is a soft grey-green colour. Another type of decoration is *underglaze* (designs painted on a piece before it is glazed). A deep blue made from the metal cobalt is the most dependable colour used for underglazing. Cobalt blue has been widely used both in China and in Europe. See **China** (picture: Fine white porcelain).

Paints that are applied over the glaze are commonly called *enamels.* A large variety of enamel colours were perfected at an early period. Most of them are made from metallic oxides, such as iron, copper, and manganese. Enamel colours require a second firing to make them permanent.

Porcelain painting in Europe differed greatly from porcelain painting in China. Chinese decorators separated each colour from the next with a dark outline, but European artists blended colours together with no separating line. In addition, Europeans used decorations purely for their artistic value, but Chinese decorations were symbolic. For example, a pomegranate design symbolized a wish for many offspring because a pomegranate has many seeds.

**Transfer printing** revolutionized the porcelain industry in 1756 by enabling workers to decorate wares much faster than they could by hand. In this process, a design is engraved on a copper plate, inked with ceramic colour, and transferred to tissue paper. While the colour is still wet, the tissue paper is pressed against a porcelain object, leaving the design on its surface.

## History of porcelain

**Oriental porcelain.** The Chinese probably made the first true procelain during the Tang dynasty (618-907). The techniques for combining the proper ingredients and firing the mixture at extremely high temperatures gradually developed out of the manufacture of stoneware. During the Song dynasty (960-1279), Chinese emperors started royal factories to produce porcelain for their palaces. Since the 1300's, most Chinese porcelain has been made in the city of Jingdezhen.

For centuries, the Chinese made the world's finest porcelain. Collectors regard many porcelain bowls and vases produced during the Ming dynasty (1368-1644) and Qing dynasty (1644-1912) as artistic treasures. Porcelain makers perfected a famous blue and white underglazed procelain during the Ming period. Painting over the glaze with enamel colours also became a common decorating technique at this time. During the Qing period, the Chinese developed a great variety of patterns and colours and exported porcelain objects to Europe in increasing numbers.

By the 1100's, the secret of making porcelain had spread to Korea and it spread to Japan in the 1500's. Workers in these countries also created beautiful porcelain objects. A Japanese porcelain called Kakiemon was first produced during the 1600's. It features simple designs on a white background. Another well-known Japanese porcelain called Imari ware, or Arita, is famous for its dense decorations in deep blue and red.

**European porcelain.** As early as the 1100's, traders brought Chinese porcelain to Europe, where it became greatly admired. However, it was so rare and expensive that only wealthy people could afford it.

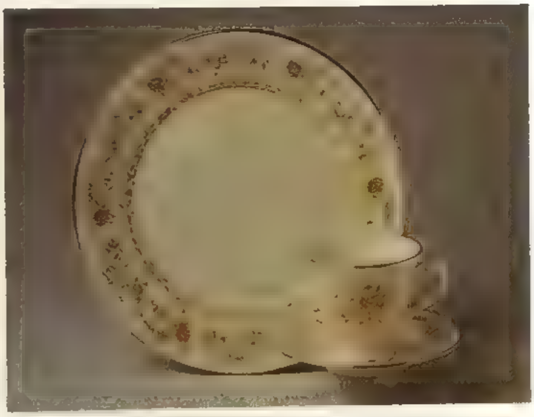
As trade with the Orient grew during the 1600's, porcelain became popular with the general public. The custom of drinking tea, coffee, and chocolate became widespread and created a huge demand for porcelain cups and saucers. European manufacturers responded by trying to make hard-paste porcelain themselves, but for a long time they failed to discover the secret. Nevertheless, some of their experiments resulted in beautiful soft-paste porcelain. The first European soft-paste porcelain was produced in Florence, Italy, in about 1575.

Metropolitan Museum of Art, New York City

**A Meissen figurine** of the mid-1700's was created by Johann Kändler, a German artist famous for his beautifully designed and decorated porcelain figures of people and animals.

By the 1700's, porcelain manufactured in many parts of Europe was starting to compete with Chinese porcelain. France, Germany, Italy, and England became the major centres for European porcelain production.

*French porcelain.* France became famous during the 1700's as the leading producer of soft-paste porcelain. The first factories were established at Rouen, St. Cloud, Lille, and Chantilly.



**Modern porcelain dinnerware** is often decorated with a delicate floral pattern.

The most celebrated type of soft-paste porcelain was first produced at Vincennes in 1738. In 1756, the factory was moved to the town of Sèvres. Its soft-paste porcelain became known as Sèvres. The earliest Sèvres had graceful shapes and soft colours. Sèvres pieces produced from 1750 to 1770 were decorated with brilliant colours and heavy gilding. Many of these pieces had richly coloured backgrounds and white panels painted with birds, flowers, landscapes, or people. Sèvres is also noted for its fine figurines of *biscuit* (unglazed porcelain).

Beginning in 1771, a hard-paste porcelain industry developed near Limoges, where kaolin deposits had been discovered. By the 1800's, Limoges had become one of the largest porcelain centres in Europe. An American named David Haviland opened a porcelain factory at Limoges in 1842 to make tableware for the American market. Haviland porcelain features soft colours that blend together and small floral patterns.

*German porcelain.* A German chemist named Johann Friedrich Böttger discovered the secret of making hard-paste porcelain in 1708 or 1709. This discovery led to the establishment of a porcelain factory in Meissen in 1710. Meissen porcelain is sometimes called Dresden because Böttger first worked near the city. For nearly a century, it surpassed in quality all other hard-paste porcelain made in Europe.

The great success of Meissen porcelain can be partly attributed to the fine artists who decorated it. They painted the wares with an amazing variety of colours and designs. Johann Höroldt (or Herold), who became chief painter in 1720, produced beautiful Chinese and Japanese as well as European designs. Johann Kändler,

who worked from about 1730 to 1770, is famous for his exquisite figures of animals and people.

Political disorder in Germany and competition from Sèvres porcelain drove the Meissen factory into decline during the late 1700's. It continued to operate but did not make wares of the same artistic quality.

***English porcelain.*** England is well known as the centre for the production of bone china. Before the invention of bone china, the English manufactured fine soft-paste porcelain at Chelsea, Bow, and Derby. Most of this English porcelain was styled after Oriental and Continental designs.

Worcester porcelain, first produced in 1751, is one of the oldest and best English porcelains. During its early years, the Worcester factory produced soft-paste porcelain, much of it decorated with Chinese designs in blue underglaze. Since the 1760's, it has manufactured bone china in a wide variety of colours and patterns.

Josiah Spode developed a bone china paste that became the standard English paste in 1800. Spode china featured a large number of designs but was especially noted for its exotic birds.

Most of the famous English Wedgwood ware is not porcelain at all, but earthenware or stoneware. Nevertheless, its classical Greek figures and reliefs became enormously popular and had a great influence on porcelain designs throughout Europe.

**Modern porcelain.** Recent technical advances have enabled the porcelain industry to produce porcelain in large quantities. Today, extensive porcelain making is carried out in Europe, Japan, and the United States. Some notable examples of fine contemporary porcelain are German Rosenthal, Japanese Noritake, and American Lennox.

**Related articles** in *World Book* include:

| | | |
|---|---|---|
| Böttger, Johann F. | Enamel | Spode china |
| Ceramics | Feldspar | Vase |
| Cobalt | Kaolin | Wedgwood ware |
| Dresden china | Pottery | |

**Porcelain enamel.** See Enamel.

**Porcupine** is an animal that has long, soft hairs and strong, stiff quills on its back, sides, and tail. Porcupine quills are long, sharp bristles of hairs that are *fused* (grown together). Porcupines defend themselves by striking attackers with their quilled tails. The quills come out easily and stick into the attacker's flesh. The porcupine grows new quills to replace the ones lost. Porcupines cannot shoot quills at their enemies, as some people believe. In some kinds of porcupines, the tip of each quill is covered with tiny, backward-pointing projections called *barbs.* The barbs hook into the flesh, and the quills are difficult to remove. Porcupine victims may die from infections caused by germs on the quills, or from damage to a vital organ. Quills may even stick in an attacker's jaw, making the animal unable to open its mouth and thereby causing starvation. *Fishers,* large members of the weasel family, attack porcupines by flipping them over onto their backs.

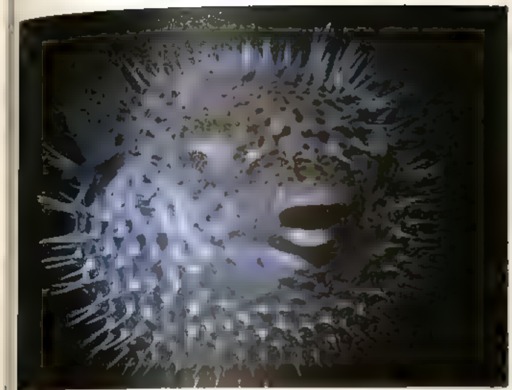
Porcupines are *rodents* (gnawing animals). Biologists classify them as *Old World porcupines* and *New World porcupines.* Old World porcupines live in Africa, Southeastern Asia, India, southern Italy, and the Balkans. Most kinds of Old World porcupines grow to about 70 centimetres long, including the tail. The *crested porcupines* of Europe have spines up to 30 centimetres long. Female crested porcupines produce an average litter of three offspring twice a year. Old World porcupines make their homes in tunnels in the ground, and do not climb trees.

New World porcupines live in North and South America. These animals spend much time in trees. Several South American porcupines, called *coendous,* can even hang by their tails. North American porcupines are about 65 centimetres long and weigh about 9 kilograms. Their yellowish-white quills are from 5 to 8 centimetres long. Their fur is brownish-black. North American porcupines live chiefly in pine forests. They eat green vegetation and tree bark. They often climb trees to strip the bark from the upper part of the tree. They may kill a tree in this way. Female North American porcupines give birth to a single offspring in the spring. The babies are born with soft quills, which harden later. North American porcupines are often incorrectly called *hedgehogs.* True hedgehogs live only in the Eastern Hemisphere. The flesh of the North American porcupine is edible, but few people consider it tasty.

**The crested porcupine** of the Kalahari Desert in southern Africa makes its home underground where it is cool.

**Scientific classification.** Old World porcupines make up the family Hystricidae. Crested porcupines are genus *Hystrix.* The porcupine of Southern Europe is *H. cristata.* New World porcupines make up the family Erethizontidae. The North American porcupine is *Erethizon dorsatum.*

See also **Animal** (picture: Animal defences and weapons).



The porcupinefish has strong, sharp spines on its body. It fills its stomach with water to make the spines stick out when threatened by an enemy.

**Porcupinefish,** also called *spiny puffer,* is a kind of fish that has sharp, protective spines covering its body. When an enemy or intruder scares a porcupinefish, the fish may enter a hole or crack in a rock and fill its stomach with water. The water causes the fish to puff up like a balloon and makes its spines stick out. If taken out of the water, the porcupinefish puffs up by filling its stomach with air. In most species, the spines lie flat against the body when the fish are calm.

There are 15 species of porcupinefish. Most are bluish, brownish, greyish, or greenish with yellow or white bellies. Some species have round black or brown spots. Porcupinefish grow to an average length of 25 to 30 centimetres. All porcupinefish have two large front teeth, one upper and one lower, that stick out like a beak. They use their teeth to feed on sea urchins, small crabs, and other hard-shelled prey. Porcupinefish live in tropical seas.

**Scientific classification.** Porcupinefish make up the porcupinefish family, Diodontidae.

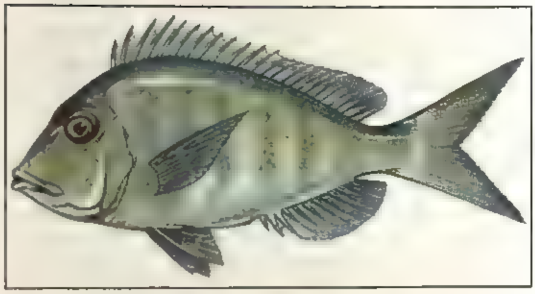
See also **Fish** (picture: The porcupinefish).

**Pore** is the tiny opening of a skin gland. The glands are like little sacks set deep in the skin. The cells inside the sacks produce sweat if the gland is a sweat gland, and oil if it is a sebaceous gland. The face has many sebaceous glands. The oil that these glands produce is normally a liquid. *Blackheads* form if the oil *cakes* (becomes solid) within the pores. If the skin around the blackheads becomes inflamed, acne pimples result. If certain kinds of bacteria get into the pores, they cause boils. A skin rash known as *prickly heat* develops when sweat glands are blocked up.

See also **Acne; Perspiration; Prickly heat; Skin.**

**Porgy** is a fish that lives in shallow areas of warm seas. The body of a porgy is oblong and has flattened sides. Most porgies are silvery in colour. Porgies are good food fish. They are caught both for sport and for commercial use.

There are more than 100 species of porgies. Several of them live along the coasts of North America. The *jolthead porgy* is probably the best known of these. It lives in the Caribbean Sea and in the Atlantic Ocean from Brazil to the New England states of the United States. The jolthead also is one of the largest porgies. It grows to a length of about 60 centimetres and weighs 3.5 to 4.5 kilograms.



**The jolthead porgy lives in Atlantic coastal waters.**

**Scientific classification.** Porgies belong to the porgy family, Sparidae. The jolthead porgy is *Calamus bajonado.*

**Porifera.** See **Sponge.**

**Pork** is the meat from pigs. People throughout the world eat more pork than any other kind of meat.

Pork is sold to consumers as fresh meat or in the form of *processed meats.* Processed meats are *cured* (treated) with a solution of salt and a chemical called sodium nitrite and then are smoked, baked, or dried. Curing and smoking give these meats a special flavour and help keep them from spoiling quickly or losing their colour. The chief processed meats produced from pork are bacon, ham, and sausage. Fresh cuts of pork include pork chops, roasts, and spare ribs.

Pork contains many *nutrients* (nourishing substances) needed by the human body. It is an excellent source of vitamins, especially *thiamine* (vitamin $B_1$). The protein in pork provides the *amino acids* needed to build and maintain body tissue (see **Amino acid**). Pork also contains such essential minerals as copper, iron, phosphorus, and zinc. Pork fat is a good source of energy and of certain *fatty acids* that the body cannot produce itself (see **Fat**).

Fresh pork sometimes contains the *larvae* (young) of a type of microscopic worm called *trichina.* A person who eats live trichina larvae may develop a disease called *trichinosis.* Thoroughly cooking fresh pork kills any trichina larvae that the meat may contain. For this reason, fresh pork should be cooked fully before it is eaten.

**Related articles** in *World Book* include:

| | | |
|---|---|---|
| Bacon | Meat | Sausage |
| Ham | Meat processing | Trichina |
| Lard | Pig | |

**Pornography.** See **Obscenity and pornography.**

**Porosity** is the existence of many small holes or spaces in a material. In some porous materials, such as charcoal, earthenware pottery, and sponges, these holes connect. Gases and liquids can pass through the holes. In other porous materials, the small spaces inside are separated from each other by solid material. Bricks and certain types of foam rubber are examples of this kind of porous material. These materials are usually able to absorb liquids and gases.

Porosity is desirable in some materials and undesirable in others. For example, porous filters of charcoal can remove impurities from the air. However, porosity in iron castings reduces the strength of the metal.

On the atomic scale, every material is considered porous because there is much free space between their atoms or molecules. For example, the spaces between the atoms of the metal palladium are large enough for hydrogen atoms to move about.

See also **Diffusion; Molecule.**

**Porphyry** (233-304), a philosopher in the Neo-Platonic group, described how all the qualities people attribute to things may be classified. This subject, put forth in his book *Introduction to the Categories,* had a great influence on medieval philosophy. It raised the problem of the status of universal propositions, which occupied logicians for hundreds of years. Porphyry was born in Tyre, in what is now Lebanon. He studied in Athens. Porphyry then travelled to Rome, where he joined Plotinus (see **Plotinus**).

**Porpoise** is the name of several sea mammals closely related to dolphins. Porpoises look much like dolphins but are smaller in size. They also differ from dolphins in the shape of the head and teeth. Porpoises have a gently sloping forehead, a rounded snout, and spade-shaped teeth. Dolphins have a steeply sloping forehead, a beak-like snout, and cone-shaped teeth. Porpoises, dolphins, and whales make up a group of mammals called *cetaceans.*

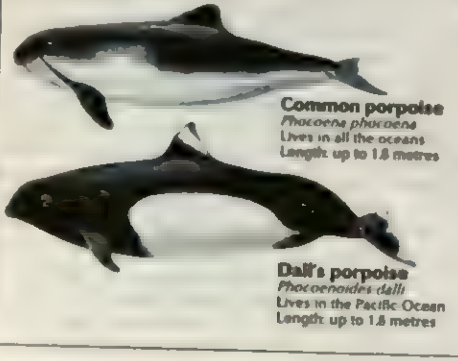
Porpoises generally roam cool, coastal waters of the Pacific and Atlantic oceans. They can swim at speeds of about 20 kilometres per hour. They eat small fish and squid. Porpoises range from about 1.5 to 2 metres in length and weigh from 50 to 100 kilograms.

There are six species of porpoises. The *harbour* or *common porpoise* and the *Gulf of California harbour porpoise,* also called *vaquiter,* are dark grey to black on the back and pale grey or white on the sides and belly. The *finless porpoise* and *Burmeister's porpoise* are almost entirely grey or black. The *spectacled porpoise* and *Dall's porpoise* have a striking pattern of black and white. Most porpoises have a thick body and a small *dorsal fin* (back fin). Only the finless porpoise lacks a dorsal fin.

Human fishing activities have severely reduced the size of the world's porpoise population. The Gulf of California harbour porpoise is an endangered species because so many have been trapped and accidentally killed in nets set for fish. Similarly, huge nets called *drift nets* have killed tens of thousands of Dall's porpoises. Many countries have agreed to stop using drift nets in ocean waters in an effort to protect porpoises and other marine life.

**Scientific classification.** Porpoises belong to the family Phocoenidae in the order Cetacea.

See also **Dolphin; Whale** (Kinds of toothed whales).



**Common porpoise**
*Phocoena phocoena*
Lives in all the oceans
Length: up to 1.8 metres

**Dall's porpoise**
*Phocoenoides dalli*
Lives in the Pacific Ocean
Length: up to 1.8 metres

**Porsche, Ferdinand.** See **Volkswagen.**

**Port** is a place where ships and boats load and unload passengers and cargoes. Large, bustling ports have buildings and equipment for receiving, storing, and reshipping goods. Such facilities include wharves, warehouses, tugs, ferries, mechanical loaders and unloaders, and railway and truck transportation (see **Ship** (Modernization of ports)). Public agencies called *port authorities* may direct the operation of major ports.

Some ports, such as Cherbourg, France, and Rio de Janeiro, Brazil, stand on natural harbours formed by bays and inlets. Others, such as Los Angeles, and Genoa, Italy, are built on artificial harbours protected by breakwaters and jetties. Many great ports lie on rivers far from the sea. Inland ports include Bordeaux, France, London; Montreal; and New Orleans, Louisiana, U.S.A.

Ports may also be classified by their purpose or function. For example, Gibraltar is a naval, or strategic, port. Concarneau, France, is a fishing port. Cape Town, South Africa, serves as a fuel-storage port for ships sailing around the tip of Africa. Kharg Island, Iran, in the Persian Gulf, is a leading port for the export of petroleum.

Much United States and Canadian commerce passes through ports on the Great Lakes. Inland waterways make it possible for all but the largest ocean ships to sail from the Atlantic Ocean to Chicago, Toronto, and other Great Lakes ports.

Among the chief ports in the United Kingdom are Aberdeen, Bristol, Liverpool, London, and Southampton. Important ports in Australia include Port Adelaide, Port Jackson (Sydney Harbour), and Port Pirie. The principal port in New Zealand is Auckland.

See also **Free trade.**

**Port Arthur,** China. See **Lüshun.**

**Port Arthur** (pop. 150) is a town in Tasmania, Australia, that was once a penal settlement for convicts. It is located on the Tasman Peninsula, about 100 kilometres by road from Hobart. Many tourists visit the town to see the relics of the penal settlement. Many of its buildings including a house, a church, a model prison, and a hospital, still stand. Sir George Arthur, governor of Tasmania, established the penal settlement.

The best-known and longest-serving commandant was Captain Charles O'Hara Booth, who served from 1833 to 1844. He established a convict railway from Taranna to Port Arthur, a semaphore signalling system to Hobart Town, and many of the industries.

Soldiers were responsible for guarding the settlement at Port Arthur. They also had a small guard at East Bay Neck and Eaglehawk Neck. They maintained a line of savage dogs across Eaglehawk Neck. The dogs were chained in such a way that they could not fight and no one could pass between them. These dogs were housed in kennels made from barrels. The soldiers placed a row of lamps about a metre above the ground so that they could see along the line. They built platforms into the sea at either end of the line so that dogs stationed on the platforms could raise the alarm if anyone attempted to pass in the water.

**Port Arthur** was an Australian penal settlement from 1830 to 1877. Its ruins are now a tourist attraction.

Many of the convicts had little or no schooling, and the administration provided classrooms where they could learn to read, write, and count while they served their sentences. Those who had mastered these skills were used as monitors. Schooling took place after supper each evening. The settlement had a library the convicts could use.

Point Puer was established as a settlement in 1834 to separate boy prisoners from adults. In 1841, there were about 800 boys there. Each boy had to attend school for half of each day, except Sunday, when morning and afternoon church services were compulsory. Trades taught at Point Puer included tailoring, sawing, blacksmithing, carpentry, coopering, boatbuilding, and baking. One half day a month was allowed for sea bathing.

The coal mines station at Plunkett Point on Norfolk Bay was established as a punishment centre. Convicts transferred there worked under harsh conditions, and some were kept in underground cells. Convicts hauled coal down a sloping tramway to the jetty to be shipped to Hobart Town.

After a report on transportation by the Molesworth Committee in 1838, a number of probation stations were set up near Port Arthur. One of these was at Saltwater River, founded in 1841 to receive prisoners from England. By 1846, there were 576 people living there, with about 50 hectares under wheat, hay, flax, hops, and vegetables. Good roads, a jetty, and many buildings were constructed. The station later ran into difficulties and closed in 1860.

See also **Convicts in Australia; Tasmania** (History).

**Port-au-Prince** (pop. 738,342) is the capital and largest city of Haiti. It lies on the Golfe de la Gonâve (Gulf of Gonâve) on Haiti's west coast. For location, see **Haiti** (map).

People from many parts of Haiti sell produce and other goods in Port-au-Prince on pavements and in a large marketplace called the Iron Market. Factories in the city produce such goods as cement, processed foods, rum, and textiles. Port-au-Prince has two cathedrals, a university, and many government buildings. It also has large slum areas, where overcrowded and unsanitary conditions reflect the poverty of many of the city's residents.

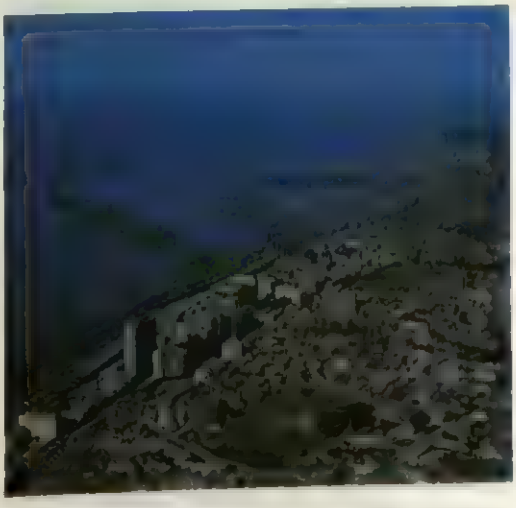
Port-au-Prince was founded in 1749 by French sugar cane planters. In 1770, it became the capital of the French colony Saint Domingue. France controlled the city until 1804, when Haiti gained independence.

See also **Haiti** (pictures); **West Indies** (picture: A crowded street market).

**Port Elizabeth** (pop. 303,353; met. area pop. 825,799) is a leading seaport and industrial city in Eastern Cape. It is located on Algoa Bay, on the southeastern coast of South Africa (see **South Africa** (political map). Products manufactured in Port Elizabeth include cars and rubber.

Tourists visit Port Elizabeth for its beaches. Other local attractions include the city's oceanarium and Addo Elephant National Park.

The area that is now Port Elizabeth was once farmed by Xhosa, Tembu, and Mpondo people. Portuguese explorers landed there in the 1400's. Fort Frederick, a military camp set up in 1799, was the first permanent British settlement in the district. In 1820, 4,000 British settlers landed in the area. They settled in and near Grahamstown, northeast of the city. Sir Rufane Donkin, acting governor of the Cape Colony, named the town after his late wife Elizabeth. Port Elizabeth was declared a city in 1913.



**Port Elizabeth** is a major seaport and manufacturing centre in South Africa. Its business district has many modern buildings.

**Port Jackson.** See **Sydney Harbour.**

**Port Kembla,** in New South Wales, is one of the fastest-growing industrial areas in Australia. It lies more than 80 kilometres south of Sydney and a few kilometres south of Wollongong. It forms part of the City of Greater Wollongong.

Port Kembla is a major centre of the iron and steel industry. Its steelworks provide employment for more than 17,000 people. It produces almost two-thirds of Australia's pig iron and more than half its raw steel. A hot-strip mill produces rolled steel for use in the shipbuilding and motorcar industries. Port Kembla has the largest electrolytic copper refining plant in Australia. It also has chemical works, cement works, firebrick works, and engineering shops. The port has a fine deepwater harbour. It does a large trade in iron and steel goods. It imports iron ore, phosphates, copper ore, and general merchandise. It exports coke, metal concentrates, coal, and timber.

Refining of crude copper at Port Kembla began in 1907. The area developed rapidly after the iron and steel works were transferred there from Lithgow, New South Wales, in 1928. In the 1930's, an artificial harbour was built.

**Port Louis** (pop. 138,482) is the capital, largest city, and leading port of Mauritius, an island country in the Indian Ocean. Port Louis lies in a lowland on the northwest coast of the country's main island, which is also called Mauritius. For location, see **Mauritius** (map). The city's main employers are textile manufacturers, food processing plants, shipping companies, and the government. Much sugar, the chief product of Mauritius, is exported from Port Louis.

France ruled Mauritius during the 1700's. The French governor founded Port Louis in 1736 and named it after Louis XV, the king of France. Although Mauritius became a British colony in the 1800's, French culture still plays an important part in the life of Port Louis.

**Port Macquarie** (pop. 22,884) is a town in New South Wales, Australia. It lies at the mouth of the Hastings River, about 418 kilometres north of Sydney. The Port Macquarie region is noted for fishing. Its oysters are among the best in the world. Port Macquarie is a popular tourist resort. Port Macquarie began as a penal settlement for notorious convicts in 1821 and became a convict hospital in 1830. It was abandoned in 1847.

**Port Moresby** (pop. 152,100) is the administrative centre of Papua New Guinea. It is also Papua New Guinea's largest town and port. Port Moresby lies on the southeastern coast of Papua. Its fine harbour is sheltered by coral reefs. For location, see **Papua New Guinea** (political map).

Port Moresby handles a quarter of the country's imports. It exports copra, rubber, and seafoods, including prawns and crayfish.

The town receives only 1,016 millimetres of rain a year. Most of the rain falls between December and April. The district around Port Moresby is not particularly fertile. But plantation owners grow rubber on the Sogeri Plateau, about 48 kilometres inland from the town. The House of Assembly, in Port Moresby, is the legislative as well as the administrative centre of Papua New Guinea. The University of Papua and New Guinea opened in Port Moresby in 1965.

Captain John Moresby sighted Port Moresby in 1873. He named the port after his father, Admiral Sir Fairfax Moresby. The inner harbour is known as *Fairfax Harbour.* The town became an administrative centre in 1884, when Britain declared a protectorate over what is now Papua. During World War II, Port Moresby was headquarters for Australian and American forces in New Guinea.

See also **Papua New Guinea.**

**Port of entry** is any place established by a government to receive foreigners, imports, and customs duties. Customs officers admit all imported goods, collect duties, and enforce the customs and navigation laws. A person who unloads foreign goods at a port that does not have a custom house is guilty of smuggling.

Ports of entry may include seaports, lakeports, and airports situated at the borders or throughout the country. A custom house may be located wherever goods of other countries are held until they are distributed to local trade.

**Port-of-Spain** (pop. 59,649) is the capital and trade centre of Trinidad and Tobago, an island country northeast of South America. The city lies on the northwest coast of the island of Trinidad. For the location of Port-of-Spain, see **Trinidad and Tobago** (map). Cacao, coconuts, coffee, fruit, sugar, rum, and other products are exported from its busy industrial and commercial harbour. Spanish colonists established Port-of-Spain as a town about 1560. A small Indian village was located there at the time.

**Port Phillip Bay** is a large inlet of Bass Strait, on the southern coast of Victoria, Australia. It has an area of 27 square kilometres and a shoreline of 225 kilometres. It extends northward for 60 kilometres from its entrance, the fast-flowing *Rip,* a narrow passage between Port Lonsdale in the west and Point Nepean in the east. Melbourne is at the head of Port Phillip Bay and Geelong is in the west.

Port Phillip Bay was first entered by Lieutenant John Murray on Feb. 15, 1802, and again by Matthew Flinders later that year. The land surrounding the bay was examined by Surveyor General Charles Grimes, who arrived on Jan. 20, 1803. In October 1803, Lieutenant Colonel David Collins tried to establish a penal settlement near Sorrento, but soon abandoned it. Two of the convicts escaped. One of them, David Gibson, travelled in the area before returning to Collins. The other, William Buckley, travelled right around the bay. Buckley lived with Aborigines west of Geelong for 32 years.

On May 29, 1835, John Batman arrived and explored the area. He concluded a treaty with the Aborigines at Merri Creek, near Northcote, now a suburb of Melbourne. Batman obtained 243,000 hectares of land, including the sites of Melbourne and Geelong. He left three Europeans and five New South Wales Aborigines to establish a garden at Indented Head, on the Bellarine Peninsula.

The *Enterprise,* owned by John Fawkner, who was not aboard, reached Port Phillip Bay and entered the Yarra River on Aug. 29, 1835. This ship left five European men and women behind to build a wharf and shelters. The five first settled near the present location of Spencer Street Railway Station, then known as *Batman's Hill.* They moved to the south bank when Batman's brother, Henry, arrived. Batman built a weatherboard house on the hill. Fawkner arrived on Oct. 10, 1835, and built a house on the north bank.

Land-hungry colonists from Van Diemen's Land (now Tasmania) soon followed. Three years after Batman's treaty with the Aborigines, the population had grown to


**Port Phillip Bay,** Australia, was first entered by John Murray on Feb. 15, 1802. John Fawkner's party established a settlement on Aug. 29, 1835, at the present site of Melbourne.

3,511 white settlers. The settlers had 311,000 sheep and 13,372 cattle. Australia's fastest-growing centre, Melbourne, was proclaimed a town in 1842 and a city in 1847. First known as *Port Phillip*, the settlement was declared a separate colony, Victoria, in 1851.

**Port Said** (pop. 399,793) is an Egyptian city that lies at the junction of the Suez Canal and the Mediterranean Sea. For location, see Egypt (political map). Its name in Arabic is *Bur Said.*

Port Said was founded in 1859 as a camp for workers who built the Suez Canal. After the canal opened in 1869, the city became one of the world's busiest ports. The canal was closed during the Arab-Israeli War of 1967, and the city lost its importance as a port. Egypt reopened the canal in 1975 and set up a free trade zone to encourage trade there (see **Free trade**). Products of Port Said include leather, refined petroleum, salt, and textiles.

**Port Said, Battle of.** See Navy (table: Famous sea battles).

**Port Sudan** (pop. 206,727), the main port of Sudan, lies on the Red Sea, 402 kilometres northeast of Atbara. For the location of Port Sudan, see **Sudan** (map). Port Sudan was founded in 1906. It is a major commercial and shipping centre, with a fine harbour and modern docking facilities. Most of Sudan's foreign trade moves through the port. Exports from Port Sudan include cotton and cottonseed, gum arabic, oilseeds, beans, hides, and cattle and sheep.

**Port Talbot** (49,900) is a town and local government district in West Glamorgan, South Wales. It is situated on Swansea Bay and has a large deep-water harbour that receives coal and iron ore. These materials are used in the huge steelworks in Port Talbot. Other local industries include those that produce chemicals.

The Port Talbot district extends some way inland, along the valley of the River Afan. Aberavon has a long beach and a large entertainment and leisure complex. See also **Glamorgan.**

**Port Said** is one of Egypt's busiest ports. It lies at the junction of the Suez Canal and the Mediterranean Sea.

**Portage** is the carrying of goods or boats overland between two bodies of water, or around some obstacle such as a waterfall or river rapids. The term *portage* is also used for the land route over which the goods are carried. North American Indians travelled long distances by portaging between rivers and lakes. The Indians travelled as far upstream as their boats could go. They then carried their canoes and goods overland to the next stream or lake, where they resumed their journey by water.

At one time, the term *portage* meant the part of the ship's cargo that was set aside as all or part of a seaman's wages. It could also mean the space set aside for such cargo, the tonnage of a vessel, and the freight charges or fees for carrying freight.

**Portal, Lord** (1893-1971), Charles Frederick Algernon Portal, was commander-in-chief of the Royal Air Force's Bomber Command in 1940. He was chief of the British Air Staff from 1940 to 1945. Portal was born at Hungerford, in Berkshire, England and educated at Winchester College and Oxford University. He served with distinction in the armed forces during World War I. Later, he became an instructor at the Imperial Defence College. He was controller of atomic energy at the Ministry of Supply from 1946 to 1951.

**Portcullis.** See **Castle.**

**Porteños.** See **Buenos Aires** (The people); **Argentina** (Way of life).

**Porter** is the family name of two United States naval officers, father and son.

**David Porter** (1780-1843), as a captain, commanded the *Essex* during the War of 1812. The *Essex* operated in the Pacific Ocean, and was the first warship to fly the United States flag in those waters. Porter almost entirely destroyed the English whaling industry in the Pacific. Porter's adopted son, David G. Farragut, who later became the Navy's first admiral, also made the voyage. Later, Porter surrendered to the English ships *Cherub*

and *Phoebe.* He returned home as a hero, and in 1815 became one of three Navy commissioners.

In 1823, Porter resigned this post to lead an expedition against pirates in the West Indies. He was insulted at Fajardo, Puerto Rico, and he forced the Puerto Rican officials to apologize. A court-martial in 1825 found him guilty of acting beyond his orders and suspended him for six months. He resigned and served with the Mexican Navy in 1826 and helped reorganize the country's naval forces.

Returning to the United States in 1829, Porter was appointed United States consul general to Algiers. He served as chargé d'affaires in Turkey from 1831 to 1839, and as United States minister to Turkey from 1839 until his death.

David Porter was born in Boston, Massachusetts, on Feb. 1, 1780. As a boy, he served on merchant ships. At the age of 18, he joined the U.S. Navy as a midshipman.

**David Dixon Porter** (1813-1891) became noted for his service in the American Civil War. In the attack on New Orleans, Louisinana, in 1862, he directed a mortar squadron under the command of his adopted brother, David Farragut. Porter fired mortar shells at Fort Jackson and Fort Saint Philip for four days. Then Farragut went past the forts and destroyed the Confederate fleet. The forts surrendered to Porter a few days later.

Later in 1862, Porter commanded the upper Mississippi squadron. In 1863, he helped the army capture the Arkansas Post. He also aided in the siege of Vicksburg, Mississippi, and became a rear admiral for this action. In 1865, as commander of 60 naval vessels, the largest fleet assembled during the war, he took part in the capture of Fort Fisher, North Carolina.

Porter became a vice admiral in 1866, and served as superintendent of the United States Naval Academy from 1866 to 1869. In 1870, he succeeded Farragut as an admiral, becoming the second person in the history of the United States Navy to hold that rank. In 1877, Porter became head of the Board of Inspection. He maintained an office in the Department of the Navy, making annual reports and influencing naval affairs.

Porter was born in Chester, Pennsylvania. At the age of 10, he went with his father to fight pirates in the West Indies. He also served with his father as a midshipman in the Mexican Navy. He fought under his cousin, Captain Henry Porter, in a battle with a Spanish vessel off Cuba and was captured. At the age of 16, Porter joined the U.S. Navy as a midshipman. He became a lieutenant in 1841, and commanded the vessel *Spitfire* during the Mexican War (1846-1848).

**Porter, Cole** (1891-1964), was an American songwriter famous for his witty lyrics and for imaginative melodies. Porter's most popular songs include "Begin the Beguine," "Night and Day," "I Get a Kick Out of You," "I've Got You Under My Skin," and "You're the Top."

Cole Porter

Porter was born in Peru, Indiana, U.S.A. He showed an early talent for music and had one of his songs published when he was only 11 years old. Several more of his songs were published while he was a student attending Yale and Harvard universities.

In 1920 and 1921, Porter studied music in Paris. His experiences there provided him with the material for *Paris* (1928), his first Broadway success. He used the life of wealthy people as the theme for many of his musicals. These shows include *Fifty Million Frenchmen* (1929), *Gay Divorce* (1932), and *Anything Goes* (1934).

In 1937, Porter injured his legs severely in a horse-riding accident. He was confined to a wheelchair for the rest of his life but, despite constant pain, wrote many more successful musicals. Among them were *Du Barry Was a Lady* (1939), *Panama Hattie* (1940), *Mexican Hayride* (1944), *Kiss Me, Kate* (1948), *Can-Can* (1953), and *Silk Stockings* (1955). He also wrote the music for the films *Born to Dance* (1936), *Rosalie* (1937), and *High Society* (1956).

**Porter, Fitz-John** (1822-1901), an American soldier, became the central figure in a celebrated military inquiry. In the American Civil War, he became a corps commander in the Army of the Potomac. At the second Battle of Bull Run (also called Manassas), Porter commanded a corps under General John Pope. Later, Pope charged him with disobedience and misconduct. A court-martial found him guilty, and he was dismissed from the army. In 1879, a board of officers reviewed Porter's case and reported in his favour. As a result, Porter was restored to his rank in 1886.

Porter was born in Portsmouth, New Hampshire, U.S.A. He graduated from the U.S. Military Academy at West Point, New York.

**Porter, George.** See Nobel Prizes (table: Nobel Prizes for chemistry—1967).

**Porter, Hal** (1911-1984), an Australian short-story writer, poet, playwright, and novelist, gained renown during the 1960's. His first book, *Short Stories,* was published in 1942. Other collections are *A Bachelor's Children* (1962) and *The Cats of Venice* (1965). A recurring theme in his stories is the betrayal of illusion and the loss of innocence. *Watcher on the Cast-Iron Balcony* (1963) and *The Paper Chase* (1966) constitute his autobiography. His other books include *The Titled Cross* (1961), a novel set in Tasmania in the 1840's, and *The Actors* (1968), which gives an image of new Japan. Harold Edward Porter was born in Melbourne.

**Porter, Katherine Anne** (1890-1980), was an American writer noted mainly for her short stories. Her *Collected Stories* (1965) won the 1966 Pulitzer Prize for fiction. Porter's most famous stories express her desire for political and social liberalism. Many of her stories contain religious symbolism, reflecting her Roman Catholic background. Porter made the setting for most of her short stories in a specific location, such as the American South or Southwest, Mexico, or Europe.

Katherine Anne Porter

Porter's major collections are *Flowering Judas* (1930); *Pale Horse, Pale Rider* (1939), a collection of three short novels; and *The Leaning Tower* (1944). Her only novel, *Ship of Fools* (1962), describes an ocean voyage from Mexico to Germany during the early 1930's. The story reflects the social and political turmoil of that time. *The Collected Essays and Occasional Writings of Katherine Anne Porter* (1970) is a collection of nonfiction. Porter was born in Indian Creek, near Brownwood, Texas, in the U.S.A.

**Porter, William Sydney.** See **Henry, O.**

**Portland** (pop. 10,136) is a town on Portland Bay in Victoria, Australia. It is 364 kilometres from Melbourne. For location, see **Victoria** (map) in this volume. The city imports phosphates, alumina, and petroleum products. It exports livestock, fodder, grain, and meat. Industries in the city include aluminium smelting, particle board manufacturing, meat processing, phosphate production, wool selling, picture frame moulding, and the manufacturing of surgical products. Portland is a fishing port and a wool-selling centre.

Lieutenant James Grant named Portland Bay after the Duke of Portland when he sailed past it in *Lady Nelson* in 1800. Later, sealers and whalers used the bay. The Henty brothers from Tasmania settled permanently at Portland in 1834. The explorer Sir Thomas Mitchell visited the area in 1836.

**Portland** (pop. 437,319; met. area pop. 1,239,842) is a city in the United States. It is Oregon's largest city and its major centre of industry and trade. It also is an important West Coast port. Portland is on Oregon's northern border, near the junction of the Columbia and Willamette rivers. Blacks, American Indians, and people of East Asian ancestry make up about 12 per cent of the population. Portland is Oregon's centre of finance and medicine.

**Portland, Duke of** (1738-1809), was twice prime minister of Britain. As a Whig (see **Whig Party**), he headed a coalition government for a short period in 1783. During the following years he changed his views, ceased to be a Whig, and became a Tory. From 1794 until 1801, he served as home secretary under William Pitt the Younger. In 1807, Portland became prime minister again, at the head of a Tory government.

William Henry Bentinck was educated at Eton College and Oxford University. He succeeded his father as Duke of Portland in 1761. After his marriage in 1765, he added his wife's family name to his own, making his surname Cavendish-Bentinck.

**Portland cement.** See **Cement and concrete.**

**Porto** (pop. 330,199; met. area pop. 1,550,800) is Portugal's second largest city. Only Lisbon is larger. Porto is also called Oporto. It is one of the country's chief seaports and serves as the commercial and industrial centre of northern Portugal. It lies on the Douro River, 5 kilometres from the Atlantic Ocean. For location, see **Portugal** (political map).

Porto is known for its role in processing and exporting Portugal's excellent port wines. The city also has food-processing plants, sugar refineries, textile mills, and other industries. Principal landmarks in Porto include the cathedral, which dates from the 1100's, and the bishop's palace, built during the 1700's. The Arrábida Bridge, one of three bridges across the Douro at Porto, is the longest concrete arch bridge in Europe. The University of Porto was founded in 1911.

Porto began as an ancient Roman trading community. During the 1700's, Porto's wine trade began to link the city closely with England. The struggle to establish a constitutional government for Portugal began in Porto in 1820.

**Pôrto Alegre** (pop. 1,108,883; met. area pop. 2,232,370) is the capital of the state of Rio Grande do Sul in southern Brazil. It lies along the Guaiba River, near the Patos Lagoon—an arm of the Atlantic Ocean. Its name means *Joyous Port.* For location, see **Brazil** (political map).

Pôrto Alegre is a major shipping, industrial, and commercial centre. A modern city, it has many skyscrapers and its riverbanks are lined with docks. Meat, timber, and tobacco from outlying rural areas are the city's chief exports. Pôrto Alegre's industries include brewing, tanning, meat processing, and wool processing. The city has many banks and other financial institutions.

Pôrto Alegre was founded in the 1740's by colonists from the Azores. In the 1800's, many German and Italian immigrants settled in the city.

**Porto-Novo** (pop. 144,000) is the official capital of Benin, West Africa. However, most of the nation's government activity takes place in the nearby city of Cotonou. Porto-Novo lies in southeastern Benin on the Lagoon of Porto-Novo, an inlet of the Gulf of Guinea in the Atlantic Ocean (see **Benin** (map)). Porto-Novo is a main trading centre for goods produced in Benin. A railway and Benin's chief river, the Ouémé, connect the city with the interior of the country.

Porto-Novo was probably founded in the 1600's by the Adja, a black African people. Later in the 1600's, the Portuguese founded a trading post in the city. Porto-Novo became a centre of the slave trade in the 1770's. French colonial influence began in the mid-1800's. The city became a regional capital of French West Africa after that colony was established in 1904. When Benin gained independence from France in 1960, Porto-Novo became the capital.

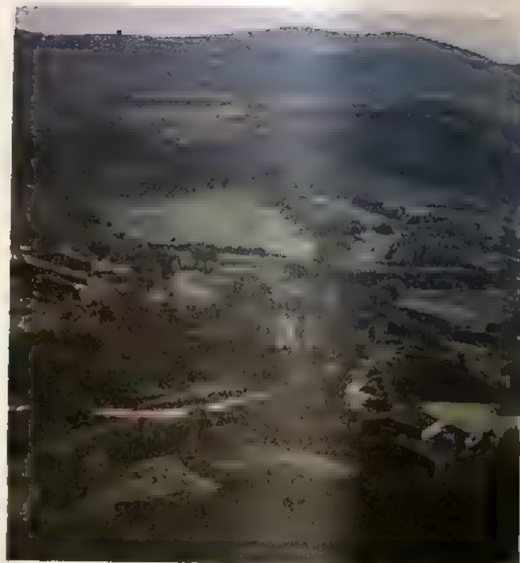
**Porto Rico.** See **Puerto Rico.**

**Portsmouth** (pop. 174,700) is a city and local government district in Hampshire, England. It is an English Channel port and naval centre, with a wide range of harbour facilities. Car and passenger ferries run from Portsmouth to ports in France, the Channel Islands, and the Isle of Wight. A hovercraft service operates to the Isle of Wight.

Portsmouth was founded in the 1100's. It became England's leading naval station after the construction of a dockyard there in the 1500's. The dockyard declined in size and use after World War II ended in 1945, but it remains the city's leading employer. HMS *Victory,* the flagship on which Horatio Nelson died at Trafalgar (1805), is in dry dock at Portsmouth. The city also has Royal Navy and Royal Marines museums.

Portsmouth has many industries. People in the area work in engineering and make clothing, computers, and electronics, packaging, and surgical products.

Portsmouth has concert and conference facilities. The district, which also incorporates the coastal resort of Southsea, has more than 7 kilometres of seafront. Its castle is a museum of military history. Charles Dickens was born in Portsmouth.



**Most of Portugal's people** live in small fishing or farming villages. A Portuguese fishing crew, *left,* prepares to leave shore. Farmland, *right,* covers much of the country. Portugal's crops include grapes, olives, and tomatoes. Wines made from Portuguese grapes are world famous.

# Portugal

**Portugal** is the westernmost country of continental Europe. It lies on the Iberian Peninsula. Spain—Portugal's neighbour to the east and north—covers most of the peninsula. Western and southern Portugal face the Atlantic Ocean. Lisbon is the country's capital and largest city.

Most Portuguese live in rural villages. The villagers include skilled people who brave the rugged Atlantic waters to fish in small boats, and farmers who grow grapes that are used to make fine wine. Fish and wine from Portugal are enjoyed by people in many parts of the world.

During the 1400's and 1500's, daring Portuguese explorers launched the Great Age of European Discovery. Bartolomeu Dias led the first European voyage around the Cape of Good Hope at the southern tip of Africa. Vasco da Gama sailed around the cape and discovered a sea route to Asia. Pedro Álvares Cabral sailed to what is now Brazil. These expeditions and many other daring voyages led to the establishment of a vast Portuguese empire that included colonies in Africa, Asia, and South America.

Portugal's power and influence began to weaken in the late 1500's. But the country held on to much of its empire for more than 400 years. In the 1960's and 1970's, however, all but three of its remaining overseas territories gained independence. These territories are the Azores and the Madeiras, Portuguese islands in the North Atlantic Ocean; and Macao, a tiny Portuguese territory located on the southern coast of China.

The 1970's brought about a major political change within Portugal. Dictators had ruled the country from 1926 to 1974. During this period, personal freedom was limited and opposition to the Portuguese government was crushed. In 1974, a group of young military officers staged a revolution and overthrew the country's dictatorship. Portugal adopted a democratic system of government in 1976.

## Government

Portugal is a republic. Its Constitution, adopted in 1976, grants the people such rights as freedom of speech, freedom of religion, and freedom of the press. Portuguese citizens 18 years or older may vote in elections.

### Facts in brief about Portugal

**Capital:** Lisbon.
**Official language:** Portuguese.
**Official name:** República Portuguesa (Portuguese Republic).
**Area:** 92,389 km², not including the Azores or the Madeira island groups. *Greatest distances*—north-south, 563 km; east-west, 201 km. *Coastline*—737 km.
**Elevation:** *Highest*—Estrela, in Serra da Estrela, 1,993 m. *Lowest*—sea level.
**Population:** *Estimated 1996 population*—9,894,000; density, 107 people per km²; distribution, 64 per cent rural, 36 per cent urban. *1981 census*—9,336,760. *Estimated 2001 population*—9,945,000. Population figures do not include the Azores or the Madeira island groups.
**Chief products:** *Agriculture*—grapes, tomatoes, potatoes, pigs, chickens, milk, beef cattle, maize. *Fishing*—sardines, tuna. *Manufacturing*—textiles, food products, paper products, electrical machinery, cork products, ceramics, shoes, cement, fertilizer.
**National anthem:** "A Portuguesa" ("The Portuguese").
**Money:** *Currency unit*—Portuguese escudo. One escudo = 100 centavos.

**National government.** A parliament called the Assembly of the Republic makes Portugal's laws. It has 230 members. The members of the Assembly are elected by the people and serve four-year terms.

The people also elect a president to a five-year term. The president appoints a prime minister—usually the leader of the political party with the most seats in the parliament. The prime minister heads the government. The prime minister and the Cabinet carry out the operations of the government.

**Local government.** Portugal—including the Azores and Madeiras—is divided into 22 districts for purposes of local government. Voters in each district elect a governor and legislature to run the district government. Cities and towns within the districts also have local governments.

**Politics.** Portugal's largest political organizations are the Social Democratic Party, the Portuguese Socialist Party, the Party of Democratic Renewal, the Portuguese Communist Party, and the Social Democratic Centre (formerly the Christian Democratic Party). In general, members of the Social Democratic Party, the Portuguese Socialist Party, the Party of Democratic Renewal, and the Social Democratic Centre favour a free enterprise economy. Members of the Portuguese Communist Party favour government control of the economy.

**Courts.** The Supreme Court of Portugal is the country's highest court of appeal. Portugal also has four lower courts of appeal, and a variety of district and local courts.

**Armed forces.** About 65,000 people serve in Portugal's armed forces. The country has an army, navy, and air force. The armed forces include both volunteers and conscripts.

## People

**Population and ancestry.** For Portugal's total population, see the *Facts in brief* table with this article. About two-thirds of the country's people live in rural areas.

Lisbon is Portugal's largest city. It has a population of about 818,000 and a metropolitan area population of more than 2,000,000. Lisbon is also the country's economic, political, and cultural centre, and it has one of the world's finest harbours. Porto, with a population of about 330,000 and a metropolitan area population of more than 1,550,000, is the only other Portuguese city with more than 100,000 people. Porto is the major economic centre of northern Portugal. About a third of the Portuguese people live in or near Lisbon and Porto. See Lisbon; Porto.

People called Iberians were the first known inhabitants of what is now Portugal. They lived there before the beginning of recorded history—about 5,000 years ago. Through the centuries, various other groups came to Portugal. They included Phoenicians, Carthaginians, Celts, Greeks, Romans, Visigoths, and North African Muslims. Today's Portuguese people are a mixture of all these groups. Since the mid-1960's, thousands of blacks from Portugal's former African colonies have moved to Portugal. These blacks form the country's only minority group.

**Way of life.** Most rural Portuguese live in small fishing or farming villages. Fishing villages line the country's coast. The people of these settlements have long relied on fishing for their livelihood. The men brave the rough waters of the Atlantic Ocean in small boats to catch fish. The women and children do such chores as cleaning the fish and mending the nets.

Portuguese farmers grow a variety of crops, but they are best known for their fine grapes that are used to make wine. Wines from Portugal are enjoyed by people in many parts of the world. Some Portuguese winemakers still follow the colourful old custom of crushing the grapes with their bare feet.

Although Portugal remains a rural country, its cities—especially Lisbon and Porto—are growing rapidly. Each year, a large number of the nation's rural people move to urban areas to find jobs in industry or other city activities. Portugal's cities have buildings that are hundreds of years old as well as modern apartment and office buildings.

The Portuguese maintain close family ties. Often, two or more generations of a family live together in the same house. Men and women who move to cities from villages tend to keep in close touch with their relatives back home.

Most Portuguese in both cities and rural areas wear clothing similar to that worn in other countries of Western Europe. But some rural people dress in styles similar to those of their ancestors. Berets, stocking caps, and

**Portugal's flag,** *left,* has a band of green, which stands for hope; and of red, which symbolizes the blood of the country's heroes. Portugal's coat of arms appears on the flag and on the right. It shows castles and shields that recall Portuguese history.


**Portugal** lies in southwestern Europe. The Azores and Madeiras, two island groups to the west, are Portuguese territories.


# Portugal map index

## Districts*

| | | | |
|---|---|---|---|
| Aveiro | 620,700 | C | 2 |
| Beja | 186,300 | F | 3 |
| Braga | 700,700 | B | 2 |
| Bragança | 181,400 | B | 4 |
| Castelo Branco | 232,400 | D | 3 |
| Coimbra | 442,900 | D | 2 |
| Évora | 179,200 | F | 3 |
| Faro | 322,900 | H | 3 |
| Guarda | 205,600 | C | 3 |
| Leiria | 423,800 | D | 2 |
| Lisboa | 2,062,200 | E | 2 |
| Portalegre | 140,600 | E | 3 |
| Porto | 1,550,800 | B | 2 |
| Santarém | 457,300 | E | 2 |
| Setúbal | 649,100 | F | 2 |
| Viana do Castelo | 256,500 | B | 2 |
| Vila Real | 264,800 | B | 3 |
| Viseu | 420,800 | C | 3 |

## Cities and towns

| | | | |
|---|---|---|---|
| Abrantes | 5,655 | E | 2 |
| Albergaria-a-Velha | 20,200 | C | 2 |
| Alcácer do Sal | 17,200 | F | 2 |
| Alges* | 20,642 | F | 2 |
| Algueirao-Mem Martins* | 27,574 | F | 1 |
| Agualva-Cacem* | 34,041 | F | 2 |
| Aljezur | 6,900 | G | 2 |
| Aljustrel | | G | 2 |
| Almada | 41,468 | F | 1 |
| Almeirim* | 9,327 | E | 2 |
| Almodôvar | 12,100 | G | 2 |
| Alpiarça* | 8,700 | E | 2 |
| Alverca do Ribatejo* | 18,806 | F | 2 |
| Amadora* | 93,663 | F | 2 |
| Amora* | 4,527 | F | 2 |
| Aveiro | 29,157 | C | 2 |
| Barcelos | 10,841 | B | 2 |
| Barreiro | 50,745 | F | 1 |
| Beja | 19,682 | F | 3 |
| Braga | 65,008 | B | 2 |
| Bragança | 13,949 | B | 4 |
| Buraca* | 9,887 | F | 2 |
| Caldas da Rainha | 16,853 | E | 1 |
| Camarate* | 10,055 | F | 2 |
| Cascais | 12,457 | F | 1 |
| Castelo Branco | 21,329 | D | 3 |
| Castro Daire | | C | 3 |
| Castro Verde | 8,900 | G | 2 |
| Chaves | 12,106 | B | 3 |
| Coimbra | 71,782 | D | 2 |
| Corroios* | 12,475 | F | 2 |
| Coruche | | E | 2 |
| Cova da Piedade* | 27,676 | F | 2 |
| Covilhã | 22,192 | D | 3 |
| Elvas | 12,673 | E | 3 |
| Entroncamento* | 10,977 | E | 2 |
| Ermezinde* | 8,266 | C | 2 |
| Espinho* | 12,883 | C | 2 |
| Estremoz | 18,300 | E | 3 |
| Évora | 34,072 | F | 3 |
| Faro | 28,213 | H | 3 |
| Fátima | 3,464 | D | 2 |
| Figueira da Foz | 12,808 | D | 2 |
| Figueiró dos Vinhos | 10,100 | D | 2 |
| Gondomar* | 18,510 | B | 2 |
| Grândola | 16,600 | F | 2 |
| Guarda | 13,118 | C | 3 |
| Guimarães | 22,054 | B | 2 |
| Ílhavo* | 31,100 | C | 2 |
| Lagos | 10,002 | H | 2 |
| Lamego | 8,647 | C | 3 |
| Laranjeiro* | 19,798 | G | 3 |
| Lavradio* | 13,605 | F | 2 |
| Leca de Palmeira* | 11,252 | C | 2 |
| Leiria | 11,189 | D | 2 |
| Lisbon (Lisboa) | 817,627 *2,062,200 | F | 1 |
| Lourinhã* | 16,900 | E | 1 |
| Lousã | 14,300 | D | 2 |
| Macedo de Cavaleiros | | B | 3 |
| Matosinhos* | 26,566 | B | 2 |
| Mértola | 14,100 | G | 3 |
| Mira | 14,900 | C | 2 |
| Mirandela | | B | 3 |
| Monchique | 12,900 | G | 2 |
| Montemor-o-Novo | | F | 2 |
| Montijo | 22,525 | F | 2 |
| Mora | 7,100 | E | 2 |
| Moscavide* | 17,717 | F | 2 |
| Moura* | 21,700 | F | 3 |
| Nazaré | | D | 2 |
| Niza | | E | 3 |
| Odemira | | G | 2 |
| Oeiras* | 32,046 | F | 1 |
| Oleiros | 11,000 | D | 3 |
| Olhão* | 19,770 | H | 3 |
| Ovar | 9,902 | C | 2 |
| Pampilhosa da Serra | | D | 3 |
| Penafiel | | B | 2 |
| Penamacor | 9,200 | D | 3 |
| Peniche | 15,647 | E | 1 |
| Pombal | | D | 2 |
| Ponte de Sor | | E | 3 |
| Portalegre | 14,824 | E | 3 |
| Portel | 8,600 | F | 3 |
| Portimão | 19,611 | H | 2 |
| Porto | 330,199 *1,550,800 | B | 2 |
| Póvoa de Varzim | 22,484 | B | 2 |
| Redondo* | 8,600 | F | 3 |
| Reguengos | 10,300 | F | 3 |
| Salvaterra de Magos | | E | 2 |
| Santarém | 15,252 | E | 2 |
| Santiago do Cacém | | F | 2 |
| Santo Tirso | | B | 2 |
| São João da Madeira | 16,237 | C | 2 |
| São Mamede de Infesta* | 5,644 | C | 2 |
| Seia | | C | 3 |
| Senhora da Hora* | 4,842 | C | 2 |
| Serpa | | G | 3 |
| Setúbal | 76,812 | F | 2 |
| Sezimbra | | F | 1 |
| Silves | | G | 2 |
| Sines | 11,300 | G | 2 |
| Sintra | | E | 1 |
| Soure | | D | 2 |
| Tavira | | H | 3 |
| Tomar | 13,766 | D | 2 |
| Torres Novas* | 9,975 | E | 2 |
| Torres Vedras | 10,655 | E | 1 |
| Vagos* | 19,200 | C | 2 |
| Valbom* | 11,945 | C | 3 |
| Vendas Novas | 15,200 | F | 2 |
| Viana do Castelo | 15,138 | B | 2 |
| Vila do Conde* | 20,226 | B | 2 |
| Vila Franca de Xira | 17,626 | E | 2 |
| Vila Nova de Gaia | 60,962 | C | 2 |
| Vila Real | 13,274 | B | 3 |
| Vila Real de Santo António | 16,800 | G | 3 |
| Vila Viçosa | 9,400 | E | 3 |
| Viseu | 21,018 | C | 3 |

*Does not appear on map; key shows general location.
*Population of metropolitan area, including suburbs.
Source: 1981 census.

baggy shirts and trousers are common among men. Many women wear long dresses and shawls. In some places, the people dress entirely in black or another dark shade for everyday activities. But they put on brightly coloured costumes for special occasions.

The chief foods of Portugal include beef; pork; chicken; fish, especially sardines; rice; and potatoes. A favourite dish is *bife com ovo a cavalo*—steak with chips and an egg on top.

The people enjoy such recreational activities as folk songs, bullfights, and soccer. Portuguese bullfights differ from those of Spain and Latin America in a major way. In Spain and Latin America, the bulls are killed at the end of the bullfights. In Portugal, it is illegal to kill the bulls during the fights.

**Language.** Portuguese is the official, and the only widely used, language of Portugal. Like Spanish, it is one of the Romance languages that developed from Latin. Portuguese and Spanish are similar in many ways. See **Portuguese language**.

**Religion.** Most Portuguese who practise a religion are Roman Catholics. The country also has small groups of Jews, Muslims, and Protestants.

Until the early 1900's, the Roman Catholic Church was, in effect, part of Portugal's national government. The church and state were separated in 1911. But Catholicism remains important to the Portuguese, especially the rural people. In many rural areas, Catholic priests have major roles in local government, education, and social life. Traditional Catholic celebrations, processions, and pilgrimages are important activities for the people. Each year, thousands of people make a pilgrimage to the Portuguese town of Fátima. There, in 1917, the Virgin Mary reportedly appeared to three children who were tending sheep (see **Fátima**).

**Education.** Portugal's educational system is weak compared with those of most other western European nations. About a fifth of the adults cannot read or write. By law, Portuguese children must attend school between the ages of 6 and 14. But many children leave school before 14. In most cases, they come from poor families and leave school to begin work. Primary education is available throughout Portugal, but many parts of the country have no secondary schools.

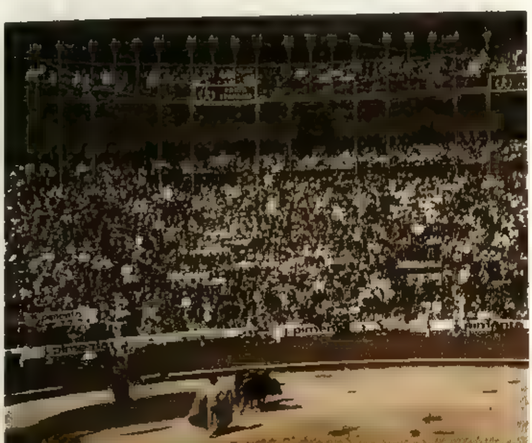
Portugal has ten universities, four of which were opened after the 1974 revolution. The largest one, Lisbon University, has more than 18,000 students. Portugal's oldest university is based in Coimbra. Less than 2 per cent of the people attend a university.

**Arts.** The golden age of Portuguese art began in the 1400's, at about the same time that the country emerged as a world power. It lasted until the 1600's. The art of the golden age was influenced by the Catholic Church, the tastes of the royalty, and the Portuguese love of the sea.

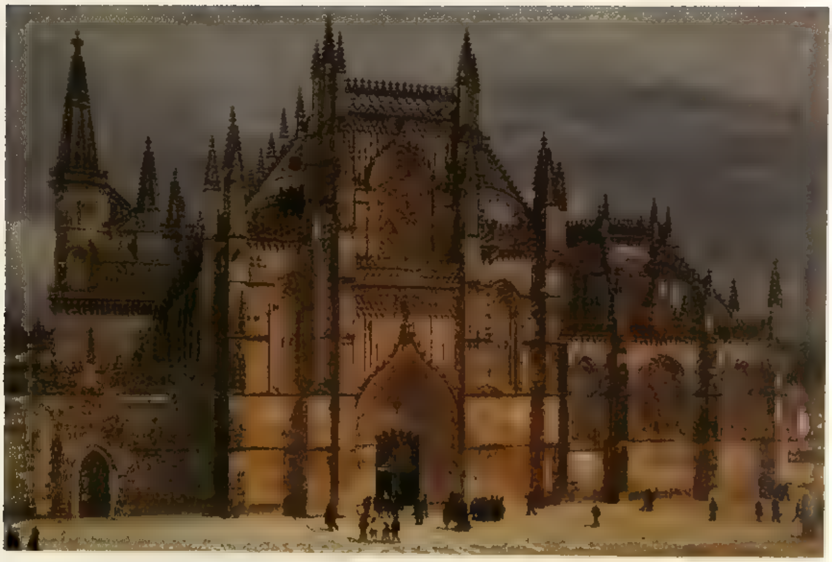
During the golden age, architects built many beautiful churches and artists decorated them with religious paintings and sculptures. These architects and artists developed a striking style noted for its elaborate use of decoration. The style is called *Manueline,* after King Manuel I, who ruled from 1495 to 1521 and sponsored many artists. A famous example of Manueline art is a church window frame at Tomar, shaped to resemble such marine items as coral, seaweed, and ship nets and ropes. Nuno Gonçalves, the best-known artist of the


**Lisbon** is Portugal's capital and its largest city. This busy, crowded city on the west coast of Portugal serves as the nation's economic, political, and cultural centre.

**An outdoor market** in the small town of Loulé attracts shoppers seeking fresh fruit and vegetables. Many Portuguese farmers regularly sell crops at such markets.



**Bullfights** attract huge crowds in Portugal. In Portuguese bullfights—unlike the bullfights of Spain and Latin America—it is illegal to kill the bull.



**A Roman Catholic church** in Batalha, *left,* is one of many magnificent churches built during the golden age of Portuguese art. Much Portuguese art and architecture during this period dealt with religious subjects.

golden age, gained fame for fine paintings of saints, kings, and princes.

The most famous literary work of the golden age was *Os Lusíadas* by Luiz de Camões. Published in 1572, this long epic poem praises Portugal's historical accomplishments and heroes.

After about 1800, religious art gave way to art that reflects everyday life. The Portuguese became known for their novels, poetry, and political cartoons.

The Portuguese also have a wealth of folk art. Their folk songs range from lively dance music called *chulas* and *viras,* to *fados* (sad songs sung to the accompaniment of a guitar). Portuguese handmade pottery, lace, and linen are prized by people in many countries.

## Land and climate

Portugal covers 88,940 square kilometres. This figure does not include the Azores or the Madeira island groups. The Azores cover 2,344 square kilometres, and the Madeiras cover 797 square kilometres. Most of Portugal is relatively flat and lies at a low altitude above sea level. But there are mountain ranges in northeastern, central, and southwestern Portugal.

**Land regions.** Portugal can be divided into four main land regions: (1) the Coastal Plains, (2) the Northern Tablelands, (3) the Central Range, and (4) the Southern Tablelands.

The Coastal Plains are flatlands that lie along and near the western and southern coasts. In some areas, the region is narrow, but in other places it extends into the centre of the country. This region supports numerous farming and fishing villages. Portugal's main cities, Lisbon and Porto, lie on the Atlantic Coast in the region.

The Northern Tablelands, Central Range, and Southern Tablelands are extensions of the *Meseta,* a huge plateau that covers most of Spain. The regions consist mainly of plains broken by mountain ranges. Farmers in these regions grow crops and raise livestock on the plains. The mountains yield a high percentage of Portugal's minerals.

Portugal's highest mountains are in the Serra da Estrela range in the Central Range region. Peaks there rise more than 1,800 metres above sea level. Estrela, Portugal's highest mountain, rises 1,993 metres in the region.

**Rivers.** Two major rivers, the Douro and the Tagus, cross Portugal from east to west. The Douro, in the north, empties into the Atlantic Ocean at Porto. The Tagus, in the centre of the country, flows into the ocean at Lisbon. The Guadiana, another important river, forms part of Portugal's boundary with Spain in the southeast.

The Tagus River divides Portugal in several ways. The area north of the river is much cooler than the area south of it. The northern area is heavily populated, while the south is thinly settled. Farms in the north tend to be small, but the south has many huge farms. In addition, the people north of the Tagus are generally more conservative politically than those south of the river. See **Tagus River.**

**Climate.** Portugal has a mild climate. The country receives a lot of sunshine, especially in the south. Holidaymakers flock to resorts in the south to enjoy the warm, sunny climate there.

In spring and summer, Portugal's weather is generally warm and dry, with little or no rain. In autumn and winter, the weather is cool and heavy rains fall on much of the country. Southern Portugal receives no snow, but parts of the north receive a little. Snow generally covers the highest peaks of the Serra da Estrela range for several months each year.

Average temperatures in Portugal range from about 21° C in July to about 10° C in January. Average annual precipitation totals about 140 centimetres in parts of the inland north, but only about 50 centimetres in the coastal south.

## Economy

Portugal ranks as one of the poorest countries in Europe. Since the 1960's however, the country has experienced economic growth.

Until the mid-1900's, Portugal's economy was based

**Portugal terrain map**


## Physical features

| | | |
|---|---|---|
| Cabo Carvoeiro (cape) | C | 1 |
| Cape St. Vincent | D | 1 |
| Cávado River | A | 2 |
| Douro River | A | 2 |
| Estrela (mountain) | B | 2 |
| Guadiana River | D | 2 |
| Minho River | A | 2 |
| Mondego River | B | 2 |
| Sado River | C | 2 |
| Serra da Estrela (mountains) | B | 2 |
| Serra de Alvelos (mountains) | B | 2 |
| Tagus River | C | 2 |

chiefly on agriculture and fishing. Today, manufacturing is the most important single element in the economy. It accounts for about 30 per cent of Portugal's economic production. Agriculture and fishing together account for about 10 per cent. Service industries, taken together, account for about 60 per cent of the economic production.

**Natural resources.** Portugal has some valuable mineral resources, but—for the most part—these resources have not been well developed. The most important developed mineral resource is building stone, which is found throughout the country. Decorative marble is the most valuable type of building stone quarried in Portugal. Portugal also has deposits of coal, copper, and wolframite. Wolframite is used to make tungsten.

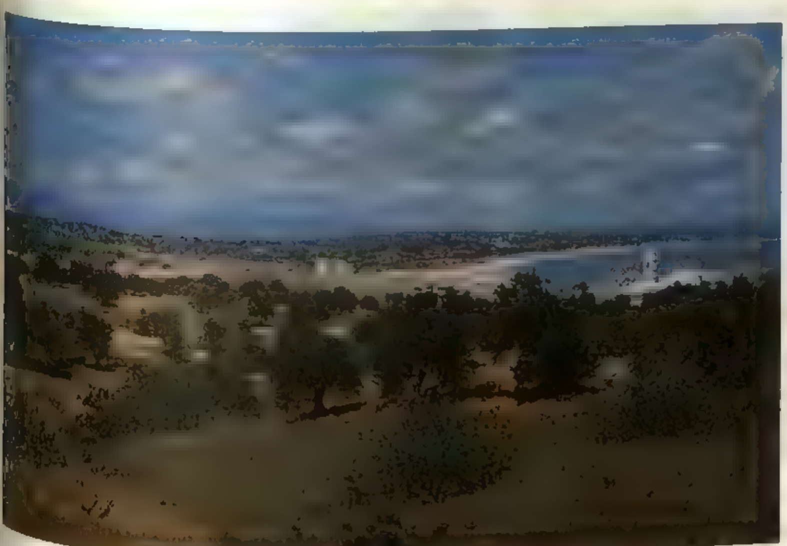
Forests cover about a third of Portugal. Large pine forests stand in the north. Forests of cork oak trees in central and southern Portugal yield large quantities of cork.

Portugal's rivers, especially the Douro and Tagus, provide hydroelectric power. The Atlantic Ocean is another important resource. Many Portuguese have long depended on its fish for their livelihoods.

**Service industries.** Government and trade are the most important service activities in Portugal. The federal government heavily controls several industries, including banks, mineral processors, and utilities. Portugal's retail trade establishments benefit from the large numbers of tourists that visit the country. Other service industries include education and health care.

**Manufacturing.** The production of textiles is the leading manufacturing activity in Portugal. Cotton fabric is the most important type of textile produced in the country. Other leading manufactured goods include food products, paper products, and electrical machinery. Portugal's food-processing activities include meat packing and the production of animal feed, canned sardines, and wine. Portuguese factories also produce cement, ceramics, cork products, shoes, and fertilizer.

**Agriculture and fishing.** Wine grapes are grown in the river valleys that cut across Portugal. The vineyards of the Douro Valley yield grapes for port wine, which is



**Flat plains** cover much of Portugal. In southwestern Portugal, *left,* the Coastal Plains rise to meet the mountains of the Southern Tablelands.

named after the city of Porto. Grapes from the Madeiras are used for Madeira wine. Other crops grown in Portugal include almonds, maize, olives, potatoes, rice, tomatoes, and wheat. Farmers rear cattle, chickens, pigs, and sheep. Fishing crews catch cod, sardines, and tuna.

Most crop farms in Portugal are small. The majority of the farmers own the land they work. But some farms, especially in the south, are state-owned collective farms. Large numbers of Portuguese farmers still use old-fashioned methods and equipment, but the use of modern farm methods and equipment increased greatly during the 1980's.

**Foreign trade.** Portugal's major exports include clothing and textiles, cork, paper, and wine. The country imports large amounts of chemicals, grain, iron and steel, petroleum and petroleum products, textile yarn and fibre, and transportation equipment.

From 1959 to 1986, Portugal was a member of the European Free Trade Association (EFTA), an economic organization of nations. In 1986, Portugal left EFTA and joined the European Community (now the European Union), a larger European economic organization of nations. Germany, a member of the European Union, is Portugal's chief trading partner. Portugal also trades heavily with other Union members, including France, Italy, Spain, and the United Kingdom, and with some other European countries. It also trades with the United States.

**Transportation.** A railway network connects most of Portugal. The national government owns and operates the main railway system. The government also owns and operates the national airline, Air Portugal. Lisbon Airport is Portugal's main international airport. Lisbon is the country's chief port.

Portugal has an average of about one car for every seven people. In cities, cars, buses, and electric trams provide much of the transportation. In rural areas, some people still travel by oxcart, horse, or mule.

**Communication.** The national government owns and operates Portugal's telephone, telegraph, and postal systems. Portugal has an average of about one radio for every five people and one television set for every six people. Many Portuguese watch television in public places, such as restaurants, taverns, and shops. Portugal has about 25 daily newspapers. The major dailies include *Correio da Manhã* of Lisbon and *Jornal de Notícias* of Porto.

## History

**Early days.** Prehistoric people probably lived in what is now Portugal more than 100,000 years ago. But the first known inhabitants of the area were members of a tribe called Iberians. These people lived on the Iberian Peninsula—in both present-day Portugal and Spain—at least 5,000 years ago.

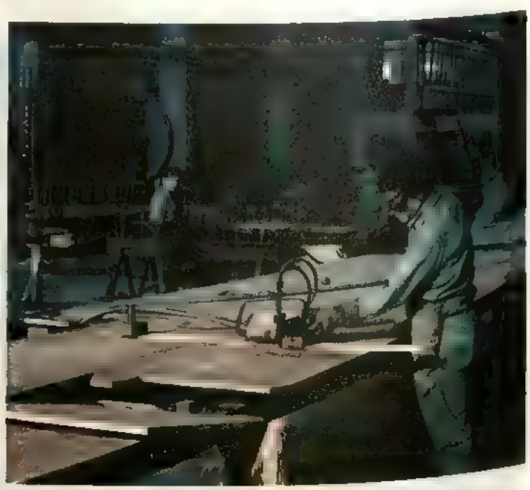
A number of groups invaded the Iberian Peninsula during early times. Phoenicians from the eastern shore of the Mediterranean Sea established settlements there in the 1000's B.C. Celts, from northern Europe, settled in the area during the 900's B.C., and Greeks arrived in the 600's B.C. Invaders from the powerful North African city of Carthage took control of much of the Iberian Peninsula in the 400's B.C.

**Roman rule.** In 201 B.C., the mighty Roman Empire defeated Carthage in the Second Punic War (see **Punic Wars**). As part of the peace settlement, Rome gained the right to the Iberian Peninsula. Little by little, the Romans conquered the peoples on the peninsula. They completed their conquest of what is now Portugal by about the time of Christ.

The Romans did much to build up the area that is now Portugal. They established cities and a network of roads there. Latin, the language used by the Romans, became the basis of both the Portuguese language and the Spanish language. The Roman Empire adopted Christianity as its official religion in the late A.D. 300's. Under Roman rule, Portugal began developing into a Christian land.

The Romans called the Portuguese portion of the Iberian Peninsula *Lusitania*. They named the port and city at present-day Porto *Portus Cale*. These words were the origin of the name *Portugal*.

**Wine made from grapes** has long been a leading product of Portugal. A labourer shovels a huge pile of grapes, *above*. The grapes will later be crushed, and wine made from their juice.



**Producing metals and machinery** is one of Portugal's major manufacturing activities. A worker in a Lisbon factory, *above*, cuts a large sheet of metal to a specified size and shape.

**Portugal's empire** in the mid-1500's, at the height of the nation's power, included colonies in many parts of the world. The map on the right shows these colonial possessions and when Portugal ruled them.

Former Portuguese territory

Present-day Portugal and territory


**Visigoths and Muslims.** Germanic tribes swept across the West Roman Empire in the A.D. 400's, and helped bring about its collapse in 476. The Visigoths, one of the tribes, conquered the Iberian Peninsula. The Visigoths were Christians, and Portugal remained a Christian land under their rule.

In the early 700's, North African *Muslims* (followers of the Islamic religion) conquered most of what are now Portugal and Spain. They influenced Portuguese civilization in many ways. They constructed Arab-style buildings, introduced new crops, and improved education and the system of roads.

Many Christians of the Iberian Peninsula opposed Muslim rule. Christian opposition was especially strong in the north. The Christians struggled to retake their land for hundreds of years. In the 1000's, they gained the upper hand. By the mid-1200's, the Christians had driven the Muslims from Portugal and from most of Spain.

**Founding the Portuguese nation.** Henry of Burgundy, a French nobleman, had joined the Iberian Christians in their fight against the Muslims. In 1094, Alfonso VI, a Christian king of Spain, rewarded Henry with the counties of Porto and Coimbra, in what is now northern Portugal. Alfonso named Henry the Count of Portugal. Portugal was then considered a part of Spain.

Henry of Burgundy's son, Afonso Henriques, won many victories over the Muslims. In 1143, he took the title of king of Portugal, and established Portugal as a kingdom independent from Spain.

In 1385, a new royal line, the House of Aviz, came to the Portuguese throne. King John I became the first Aviz king. His armies defeated Spanish forces and helped guarantee the future independence of Portugal from its powerful neighbour to the east. King John also made an alliance with England. This alliance, still in force, is the oldest existing political alliance in Europe.

**The age of exploration.** Even before the 1400's, Portuguese traders and fishermen had sailed far from home into the Atlantic Ocean. By 1400, the Portuguese had gained much knowledge about the sea. They had also mastered navigational skills and the ability to build ships capable of making long voyages.

Henry the Navigator, a son of King John I, was a leading figure in Portugal's rise as a sea power. He never went on a voyage himself. But his studies contributed much to the Portuguese marine skills, and he encouraged and sponsored many explorations.

Portuguese seamen reached the Madeira Islands in 1419 and the Azores in 1431. By the time of Henry's death in 1460, the Portuguese had explored the west coast of Africa as far south as what is now Sierra Leone. In 1488, a Portuguese vessel commanded by Bartolomeu Dias sailed all the way around the Cape of Good Hope, at the southern tip of Africa. The voyage marked the first time Europeans had rounded the cape.

Manuel I, called Manuel the Fortunate, became king of Portugal in 1495. Determined to increase his country's power and importance, he decided to sponsor a daring voyage around southern Africa to Asia. Vasco da Gama undertook this task in 1497. He led four ships around the Cape of Good Hope, and reached India in 1498. Manuel soon sent Pedro Álvares Cabral to follow Da Gama's route, but Cabral drifted off course. In 1500, his fleet reached the east coast of what is now Brazil. The Portuguese also reached the coasts of Africa, the Arabian and Malay peninsulas, the East Indies, and the Orient.

**Empire and wealth.** Settlers and soldiers followed closely behind the Portuguese explorers, establishing

**Important dates in Portugal**

| | |
|---|---|
| **1000's B.C.** | Phoenicians established settlements in what is now Portugal. |
| **100's B.C.** | Portugal became part of the Roman Empire. |
| **A.D. 711** | Muslims invaded the Iberian Peninsula. |
| **1143** | Portugal became an independent nation. |
| **1419** | Portugal began its overseas expansion. |
| **1497-1498** | Vasco da Gama sailed around Africa to India. |
| **1500** | Pedro Álvares Cabral claimed Brazil for Portugal. |
| **1580** | Spain invaded and conquered Portugal. |
| **1640** | Portugal regained its independence. |
| **1822** | Portugal lost its colony of Brazil. |
| **1910** | The Portuguese established a republic. |
| **1928** | António de Oliveira Salazar, who ruled as a dictator for 40 years, began his rise to power. |
| **1960's** | Rebellions against Portuguese rule broke out in the country's African colonies. |
| **1974** | A revolution overthrew the Portuguese dictatorship. |
| **1975** | Almost all remaining Portuguese colonies gained independence. |
| **1976** | Portugal held its first free general elections in more than 50 years. |
| **1986** | Portugal joined the European Community. |

colonies. By the mid-1500's, Portugal controlled a vast overseas empire that included colonies in what are now the African countries of Angola, Cape Verde, Guinea-Bissau, Mozambique, and São Tomé and Príncipe, and in Brazil, Malaysia, Indonesia, and China.

Portugal gained great wealth from the resources of its colonies. It profited from the spice trade in Asia. It got gold from Africa and also took part in the slave trade there. Brazil yielded such valuable items as diamonds and gold. The empire also gave Portugal vast amounts of new land. Portuguese planters in Brazil, Africa, and elsewhere raised crops that contributed to the country's economy.

**Years of decline.** Portugal held on to much of its empire well into the 1900's. However, the country declined as an economic and world power much earlier.

As far back as the late 1500's, there were signs that Portugal had overextended itself. The small nation found that it had too few ships, settlers, soldiers, and sailors to manage and defend its vast empire well.

During the 1600's, rival European states, including England, the Netherlands, and France, began to take over parts of the empire.

Internal policies and the effects of the Inquisition also contributed to Portugal's decline. Its kings had gained enormous power, and they ruled the people with strict measures. The Inquisition was an effort by the Roman Catholic Church to end *heresy* (opposition to its teachings). It further hurt the country's cultural and economic development. Many Portuguese Christians and Jews were killed or imprisoned during the Inquisition, and thousands of Jews were expelled from the country.

**Spanish conquest.** Spain invaded and conquered Portugal in 1580, and ruled the country for 60 years. In 1640, John, Duke of Braganza, led a rebellion that drove out the Spaniards and restored Portugal's independence. John became the first king of the House of Braganza, the last Portuguese line of monarchs. He took the title of John IV.

**A brief revival.** Portugal entered a period of economic revival in about 1660. Revenue from Brazil's gold, diamonds, and farm products contributed greatly to the upsurge. A trade agreement made with England in 1703 also aided Portugal. Called the Methuen Treaty, it ensured steady trade between the two countries that benefited both.

England also helped Portugal maintain its status as an independent nation. Spain sought to regain control of Portugal, but England—an enemy of Spain—pledged aid to Portugal against foreign invaders. Between 1703 and the mid-1800's, the English acted several times to defend Portugal from invasion or threats by Spain or Spain's allies. In 1807, French forces under Napoleon I invaded and conquered Portugal. But England raised an army under the Duke of Wellington that finally drove the French forces from Portugal in 1811. The brief period of French rule marked the last time Portugal was controlled by outsiders.

**A weakening monarchy.** King John VI of Portugal fled to Brazil during the French occupation. He returned to Portugal in 1821. By that time, a spirit of political reform had grown strong in Europe. Many Portuguese demanded a more representative government and a limit to the power of the king. Portuguese army officers had revolted in 1820. In 1821, King John agreed to a constitution that provided for some representative government.

In 1822, the Portuguese empire suffered a major blow. Brazil, the wealthiest part of the empire, declared its independence. See **Brazil** (History).

**The first Portuguese republic.** For many years, Portugal made little actual progress toward true representative government. The monarchy remained strong and the people had little voice in government. Opposition to the government grew steadily. In 1908, King Carlos I and his eldest son were assassinated in Lisbon by revolutionaries who wanted to end the monarchy's power. The king's young son, Manuel II, then came to the throne, but revolutionaries overthrew him in 1910 and established Portugal as a republic.

Portugal's first attempt at parliamentary democracy was a failure. It was marked by excessive government interference in society and political instability. In 15 years, the country had 45 different governments. The republic's leaders faced labour unrest and revolts by the military and civilians. Portugal fought on the side of the Allies during World War I (1914-1918), and the war costs weakened its already shaky economy.

**The Salazar dictatorship.** In 1926, army officers overthrew Portugal's civilian government. They abolished parliament, suspended civil rights, and set up a dictatorship. The officers were unable to solve the country's economic problems. In 1928, they chose António de Oliveira Salazar, an economics expert, to serve as minister of finance. But Salazar's role soon extended far beyond financial matters. Salazar soon took control of the government and began to rule as a dictator. He was named prime minister in 1932.

Salazar's government was a *right-wing* (conservative) dictatorship. It allowed the people few rights, and it included a secret police organization that crushed all opposition. Salazar's economic policies favoured the wealthy, and poverty spread during his dictatorship.

In the mid-1900's, most European nations began granting independence to colonies they still held. But Salazar refused to give up Portugal's remaining colonies in spite of demands from the colonies' peoples and the United Nations. Salazar continued to stress the unity of Portugal and its colonies, which, after 1951, were called *overseas provinces.*

In 1961, Indian troops forced Portugal to give up its last colonial holdings in India. At about the same time, rebels in Portugal's black African colonies of Angola, Mozambique, and Portuguese Guinea (now Guinea-Bissau) began armed struggles against their Portuguese rulers. Portugal sent troops to fight the rebels. Thousands of people on both sides were killed, and the cost of the fighting further weakened Portugal's economy.

Salazar suffered a stroke in 1968, ending his long public career. He died two years later. Marcello Caetano replaced him as Portugal's ruler in 1968. Caetano took steps to reduce the harsh rule of the dictatorship, but not enough to suit many Portuguese.

**The 1974 revolution.** Military officers overthrew the dictatorship in 1974. They called their revolution the *Armed Forces Movement.* The movement abolished the secret police, restored rights to the people, and established a provisional government to run the country.

As part of the reforms, political parties were per-

...ed in Portugal for the first time since the 1930's. ...mmunists, Socialists, and parties that favoured free ...terprise sought to control the new government. In ...74 and 1975, violence between Portuguese people of ...ffering political views broke out.

**End of the empire.** Portugal's new government promised to end the country's control of its colonies. The African land of Portuguese Guinea gained independence as Guinea-Bissau in 1974. Angola, Cape Verde, Mozambique, and São Tomé and Príncipe—also in Africa—all gained independence from Portugal in 1975. In 1976, Portugal's colony of Portuguese Timor in the East Indies was taken over by Indonesia.

Portugal thus rules only its mainland territory and the Azores and Madeira Islands. Technically, it also has one other small territory—Macao, on China's southern coast—but actually has little control over it.

**Portugal today.** In 1976, Portugal held its first free general elections in more than 50 years. The elections established a *constituent assembly* to write a constitution for the country. The voters elected a Parliament and a president. The prime minister, who is usually the leader of the political party with the most seats in Parliament, heads the government. The Portuguese military retained an advisory role in the government until 1982.

Since 1976, control of Portugal's government has changed hands a number of times. Political parties, such as the Social Democratic Party and the Socialist Party, have usually found it necessary to band together in coalitions. Such coalitions are then able to gain enough seats in Parliament to control the government.

In 1986, Portugal joined the European Community (now the European Union), an economic organization of European nations. From 1959 until it joined the European Community, Portugal had been a member of an economic organization called the European Free Trade Association (EFTA).

The need to establish greater cooperation among political groups is one of Portugal's major problems today. Portugal has experienced economic growth since the 1960's. But it has also faced economic problems. Its costly wars in Africa and the internal violence that followed the 1974 revolution helped bring the economy to a state of near collapse temporarily. Since the revolution there have been periodic problems of inflation and high unemployment.

**Related articles** in *World Book* include:

**Biographies**

| | | |
|---|---|---|
| ...ral, Pedro Á. | Henry the Navigator | Pedro (I) |
| ...a Gama, Vasco | John VI | Salazar, António |
| ...s, Bartolomeu | Magellan, Ferdinand | |

**Cities and towns**

| | | | | |
|---|---|---|---|---|
| ... | Fátima | Funchal | Lisbon | Porto |

**History**

| | | |
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| ...ica (The beginnings of European control) | Guinea-Bissau | Macao |
| ... | Iberia | Mozambique |
| ... | Kongo | São Tomé and Príncipe |
| ... | Latin America (History) | Timor |
| ...e Verde | Line of Demarcation | World War I |
| ...ploration | | |

**Physical features and districts**

| | | |
|---|---|---|
| ... | Madeira Islands | Tagus River |

**Other related articles**

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| Cork | Portuguese language |
| European Union | |

**Outline**

I. Government
   A. National government
   B. Local government
   C. Politics
   D. Courts
   E. Armed forces
II. People
   A. Population and ancestry
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III. Land and climate
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   C. Climate
IV. Economy
   A. Natural resources
   B. Service industries
   C. Manufacturing
   D. Agriculture and fishing
   E. Foreign trade
   F. Transportation
   G. Communication
V. History

**Questions**

What is the origin of the name *Portugal*?
What were the roles of Afonso Henriques, Henry the Navigator, and Manuel I in Portuguese history?
What were some features of Portuguese golden age art?
What are Portugal's chief crops?
How did explorations bring wealth to Portugal?
Why is the town of Fátima important?
How does the Tagus River serve as a dividing line?
Which country is Portugal's oldest ally?
What are Portugal's main land regions?
What problems does Portugal face today?

**Portuguese discovery of Australia** has been the subject of debate among experts for nearly 200 years. The debate revolves around whether or not the Portuguese were the first Europeans to discover Australia. Some experts have argued that the Portuguese discovered Australia in the 1500's, about 100 years before the Dutch explorer Willem Jansz made the first documented sighting of the continent in 1606.

The strongest recent argument for a Portuguese discovery was made by K. G. McIntyre in his 1977 book, *The Secret Discovery of Australia*. McIntyre argued that his research in Portuguese archives showed that a Portuguese captain named Cristovao de Mendonca charted the east coast of Australia to Warrnambool, Victoria, in 1522. This charting would have occurred about 250 years before James Cook's visit of 1770. McIntyre also claimed that the northwest coast of the continent was charted by Portuguese expeditions sailing south from Timor in the early 1500's.

Other evidence McIntyre offered included the unearthing of artefacts in Australia and New Zealand that may have been Portuguese in origin. These artefacts include two bronze cannons found in Napier Broome Bay, on the northwest coast, the Tamil Bell and Spanish helmet found in New Zealand, and the so-called *Mahogany Ship*—a wrecked ship dating from the 1500's. The wreckage was sighted at various times on the beach at Warrnambool between 1836 and 1880. It eventually vanished beneath the shifting sand.

The strongest evidence McIntyre presented was the depiction of a land mass resembling Australia on the Dieppe Maps. These maps were drawn in Dieppe, France,

between 1536 and 1566 and are generally acknowledged to be Portuguese in origin. The land mass is positioned at Australia's correct latitude but at a different longitude. McIntyre claimed that the imperfect mapmaking techniques of the 1500's account for the difference. He claimed that if certain corrections are made to allow for these techniques, then the southern land mass indisputably emerges as Australia.

Other scholars have refuted all of McIntyre's major claims. But a Portuguese discovery remains a likely possibility because of the many Portuguese voyages in the Indian Ocean during the 1500's.

**Portuguese East Africa.** See Mozambique.

**Portuguese Guinea.** See Guinea-Bissau.

**Portuguese language** is the official language of Portugal, Brazil, Mozambique, and Angola. The language is also spoken by about 300,000 people in the United States. About 2 million people in northwestern Spain speak a Portuguese dialect called *Galego* or *Galician.* There are four principal dialects of Portuguese spoken today. The *Northern, Central,* and *Southern* dialects are used in Portugal and the *Brasileiro* dialect is spoken in Brazil. Portuguese is a Romance language similar to Spanish. The Romance languages developed from Latin (see **Romance languages**).

Portuguese and Spanish were essentially the same language until about A.D. 1143, when Portugal broke away from Spanish control. As Portuguese evolved, it developed distinctive phonetic and grammatical characteristics. Portuguese colonizers carried the language to Brazil during the 1500's. The Brazilians added words from the Tupi Indians and from African slaves. Brazilian Portuguese came to have the same relation to the language that American English has to British English.

Since the early 1900's, many people in Portugal and Brazil have wanted to simplify and standardize Portuguese spelling. Scholars wished to take out many double consonants and other old-fashioned letter combinations. In 1943, the governments of Portugal and Brazil approved a new system, in which *f* is substituted for *ph, t* for *th,* and *i* for *y.*

See also **Spanish language** (Development).

**Portuguese man-of-war** is a floating creature found in warm seas throughout the world. Although it resembles a jellyfish, it actually consists of a colony of hundreds of members.

The colony begins with just one *larval member.* As it grows, this original member produces new organisms of several different types, by a process called *budding* (see **Reproduction** [Asexual reproduction in animals]). The original member develops into a blue, balloonlike *float* that is filled with gas. This structure keeps the colony afloat. It also acts as a sail, catching the wind and moving the colony about.

The other members of the Portuguese man-of-war colony hang from the float. Stringlike members called *tentacles* catch food. When touched, the tentacles discharge poison that paralyses and kills fish. The tentacles then haul the prey up to tube-shaped members that digest food for the entire colony. Other members produce the eggs and sperm necessary for reproducing new colonies.

A large Portuguese man-of-war may have a float 25 centimetres long and tentacles 9 metres long. These animals were probably named by sailors, who thought the float resembled a type of sailing ship called a *man-of-war.*

**The Portuguese man-of-war** floats on the surface of warm seas. It catches food with its submerged poisonous tentacles.

The Portuguese man-of-war often stings swimmers. Although it is rarely fatal, the sting causes a severe skin rash, extreme pain, nausea, and breathing difficulties. A Portuguese man-of-war washed up on the beach remains dangerous and should not be touched.

**Scientific classification.** The Portuguese man-of-war belongs to the phylum Cnidaria. Its scientific name is *Physalia physalis.*

**Portuguese water dog** is a breed of dog noted for its exceptional swimming ability. Portuguese water dogs can swim as far as 8 kilometres and dive to depths of about 4 metres. For hundreds of years, the Portuguese have used these dogs in fishing to pull fish and nets from the sea. The dogs have also served as messengers between ships.

The origins of the Portuguese water dog are uncertain. According to one theory, sheepdogs in southern Russia were the ancestors of the Portuguese water dog. Migrating tribes had brought the sheepdogs to northwestern Africa by the 700's. From there, Moor invaders carried the dogs to Portugal, where they were bred to become water dogs.

Portuguese water dogs are muscular and have webbed feet and a tail that curls over the back. The webbed feet enable the dogs to tread water, and the tail serves as a rudder while swimming. Males stand about 50 to 57 centimetres tall at the shoulder and weigh 19 to 25 kilograms. Females are slightly smaller. The dog's

**The Portuguese water dog** is a strong swimmer. For hundreds of years, it has served as a working companion to Portuguese fishing crews, who have used it to pull in fish and nets.

coat may be long and wavy or short and curly. The most common colours are black and white, and brown and white.

**Portuguese West Africa.** See **Angola.**

**Portulaca** is the name of a group of herbs with dainty red, yellow, pink, white, or purple flowers. The *rose moss* of Brazil, grown as a garden flower, grows flat or as tall as 30 centimetres. It has narrow, fleshy leaves about 2.5 centimetres long.

The *kitchen garden portulaca,* also called *purslane,* grows about 45 centimetres tall, with bright yellow flowers about 15 millimetres wide and broad leaves.

Portulacas make beautiful plants for a border or a rock garden. They grow best in a sunny location in poor, rather light soil. The flowers open only in full sunlight. Several species make charming potted plants. But they are not satisfactory as cut flowers.

**Portulaca**

**Scientific classification.** Portulacas belong to the purslane family, Portulacaceae. Rose moss is classified as *Portulaca grandiflora,* and the kitchen garden portulaca as *P. oleracea.*

See also **Purslane.**

**Poseidon** was the Greek god of the sea. He was also a god of horses, earthquakes, and storms at sea. Neptune, the chief sea god of the ancient Romans, resembled Poseidon.

Poseidon was the son of Cronus and Rhea, and the brother of Zeus, the king of the gods. His wife was Amphitrite, a sea goddess. Poseidon had many offspring, including Antaeus, a giant; Arion, a wondrous horse; Polyphemus, a *Cyclops* (one-eyed giant); and Triton, a half-man and half-fish creature called a *merman.* Poseidon's anger toward the Greek hero Odysseus (called Ulysses in Latin) for blinding Polyphemus is a major theme of the epic poem the *Odyssey.* Poseidon's attendants included sea goddesses called *Nereids* and a wise old man named Proteus who could change his shape and foretell the future.

Ancient artists portrayed Poseidon as bearded and majestic, with a stern expression. He drove a chariot drawn by horses and carried a three-pronged spear called a *trident.*

See also **Neptune; Triton; Andromeda.**

**Positive charge.** See **Electricity** (Kinds of electricity).

**Positive number.** See **Algebra** (Positive and negative numbers).

**Positivism** is a variation of the philosophical theory called *empiricism.* This theory states that all knowledge is based on experience. There are two main forms of positivism. Auguste Comte, a French philosopher, developed the first form of positivism in the 1800's. The second form, known as *logical positivism,* originated in the 1920's among a group of philosophers called the Vienna Circle.

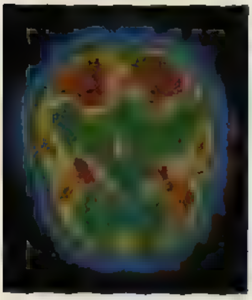
**Comte's positivism** is based on his three-stage evolutionary account of history. According to Comte, human thought goes through three stages, which he set out in a six volume work, *The Course of Positive Philosophy* (1830-1842). These stages are (1) theological, (2) metaphysical, and (3) positive or scientific. In the theological stage, people explain existence in terms of the actions of divine beings. During the metaphysical stage, explanations are sought in terms of basic causes and principles. In the positive stage, people use the *positive method* to explain existence. This method consists of reasoning by reference to observation alone.

Comte urged that the positive method be used for all scientific study, including the study of humanity. He argued that humanity should be studied through biology and *sociology,* a term he originated. Comte taught that progress should aim for *sociocracy,* a social state based on science and a new *religion of humanity.* Philosophers would govern this state according to the principles of positivism. See **Comte, Auguste.**

**Logical positivism** was developed by the Vienna Circle under the leadership of the German physicist and philosopher Moritz Schlick. The group included the German philosopher Rudolf Carnap and several other leading philosophers and scientists. Its main doctrine was a controversial idea called the *verifiability criterion of meaning.* According to this doctrine, all statements that cannot be verified by sense perception—except for provable statements of mathematics or logic—are meaningless nonsense. The Vienna Circle aimed to eliminate such unverifiable statements and ideas from science and philosophy.

**Positron.** See **Anderson, Carl David; Antimatter; Radioactivity** (Beta radiation).

**Positron emission tomography (PET)** is a technique used to produce images of the chemical activity of the brain and other body tissues. PET enables scientists to observe chemical changes in specific regions of a person's brain while the person performs various tasks, such as listening, thinking, or moving an arm or leg. Scientists use PET to compare the brain processes of healthy people with those of people with diseases of the brain. Research is being done to see if it is possible to use these comparisons to identify abnormalities that



**A PET scan** produces images of the brain's chemical activity. The patient's head is placed inside a ring of sensors, *above,* which pick up gamma ray signals from the brain. A computer processes these signals to form a cross-sectional colour image, *left.* The colours show the rate of activity in specific brain regions. Red indicates a high rate of activity.

underlie various brain disorders. These disorders include such mental illnesses as manic depression and schizophrenia, as well as such conditions as Alzheimer's disease, cerebral palsy, epilepsy, and stroke. PET also helps doctors diagnose certain other disorders, including heart disease and cancer.

In a PET scan of the brain, the patient's head is positioned inside a ring of cameralike sensors. These sensors can detect *gamma rays* (short-wave electromagnetic radiation) from many angles. A solution containing glucose bound to a harmless amount of a radioactive substance is injected into a vein. This radioactive *labelled glucose* mixes with the glucose present in blood and soon enters the brain.

The radioactive substance gives off *positrons,* particles identical to electrons but carrying an opposite electric charge (positrons have positive charge, electrons have negative charge). The positrons collide with electrons present in brain tissue and gamma rays are *emitted* (given off). The sensors record the points where these rays emerge. A computer then assembles these points into a three-dimensional representation of the emitting regions. This representation is displayed on a video screen as cross-sectional "slices" through the brain.

Colours in a PET image show the rate at which specific brain structures consume the glucose. The rate of glucose consumption indicates how active these structures are during a particular task. For example, if the person having the PET scan looks at an object, the brain region that receives and interprets visual signals will appear red on the screen. Red indicates the highest rate of activity. Other colours that appear in PET images include orange—the next highest rate of activity—yellow, green, and blue, the lowest rate.

**Possession.** See Exorcism.

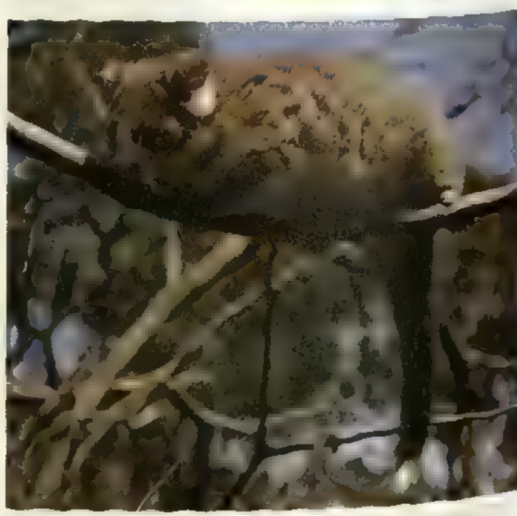
**Possession Island** is a small, hilly, grass-covered island situated west of Cape York on the far northeastern coast of Australia. Captain James Cook landed there after sailing up the eastern coast of Australia. On Aug. 20, 1770, he claimed for England the eastern coast of the continent from latitude 38° S to latitude 10° 30'S. Cook named this area *New South Wales* and called the island *Possession Island.*

**Possessive case.** See Case.

**Possum** is a furry mammal that lives in the trees of Australia, New Guinea, and nearby islands. Possums are *marsupials*—that is, the females give birth to extremely immature young that complete their development while attached to the mother's nipples. Like most marsupials, young possums develop while carried about in a pouch on their mother's abdomen. Both possums and opossums are marsupials, but they are not closely related. Possums, along with *cuscuses,* make up a group of mammals called *phalangers* (see Cuscus).

Possums move about at night and sleep during the day. They have handlike hind feet that help them grasp the branches of trees. Possums eat mainly blossoms, fruit, insects, and sap. The animals have black, brown, grey, tan, or white fur.

There are about 40 species of possums. The common brush-tailed possum lives in Australian cities and raids fruit trees and dustbins for food. Brush-tailed possums weigh from about 1.5 to 5 kilograms. The mouse-sized honey possum has a tube-shaped mouth and feeds on



**The ring-tailed possum,** *above,* like many species of possums, has a long tail that it uses to grasp branches.

nectar and pollen. Pygmy possums, which also resemble mice, weigh as little as 14 grams. Several species of possums, called *gliders,* have large folds of skin between the front and rear legs on each side of the body. When the legs are spread, this skin serves as wings for gliding from one tree to another. All Australian possums have two long lower front teeth that project forward horizontally. The first toes on their hind feet are large and thumblike. The second and third toes are fused to form a grooming comb. Many *species* (kinds) can use their tails for grasping.

**Scientific classification.** The common brush-tailed possum belongs to the family Phalangeridae. It is *Trichosurus vulpecula.* The honey possum is the only member of the family Tarsipedidae. It is *Tarsipes rostratus.* Pygmy possums belong to the family Burramyidae; and gliders to the family Petauridae.

**Post, Wiley** (1899-1935), a pioneer American aviator, was the first person to make a solo flight around the world. He made the historic flight in 1933 in a single-engine Lockheed Vega aeroplane nicknamed *Winnie Mae,* covering 25,099 kilometres in 7 days 18 hours 49 minutes. Post used a new automatic pilot system that steered the plane while he rested. Two years earlier, Post and navigator Harold Gatty had flown the *Winnie Mae* around the world in a record 8 days 15 hours 51 minutes.

**Wiley Post**

Post was born in Van Zandt County, Texas. He learned to fly in the 1920's and bought his first plane in 1926. Post flew in a number of speed events, winning the U.S. National Air Race of 1930.

Post later advanced high-altitude flight by helping design a rubber suit that allowed him to operate in low air pressures at more than 9,000 metres. Post died in a plane crash in Alaska with his friend, the cowboy-humorist Will Rogers.

**Post mortem.** See **Autopsy.**

**Post office** is a place where mail is handled and where postage stamps, other postal materials, and services are sold. The term *post office* or *postal service* also refers to the agency that provides mail services. In some countries, telecommunications are a part of post office business.

In many countries, the government runs the post office. In others, a specialist agency operates the service. For example, in the United Kingdom, the Post Office is a public corporation funded by and responsible to the government. Telecommunications are run by private companies. In the Republic of Ireland, the post office, An Post, is a state-owned company. A statutory body, Telecom Eireann, handles telecommunications services.

In Australia, the Australian Postal Commission, an independent statutory body, handles postal services. It operates under the name *Australia Post.* Another independent statutory body, the Australian Telecommunications Commission, handles internal telecommunications services under the name *Telecom Australia.* Overseas telecommunications services are operated by the Overseas Telecommunications Commission. In New Zealand, the Post Office runs the postal services and Telecoms New Zealand operates telecommunications.

In India, both postal services and telecommunications are run by the government Posts and Telegraphs Department.

In many countries, the local post office is a centre of community life. Yet it is only a small part of the post office organization. Some post offices are large buildings in the centres of towns. Other smaller post offices may form part of a shop in a village.

Almost everyone depends on the post office. By means of letters, people can share news and make plans with friends and relatives far away. Shops and other businesses send bills and receive payments through the mail. Many magazines are delivered by mail.

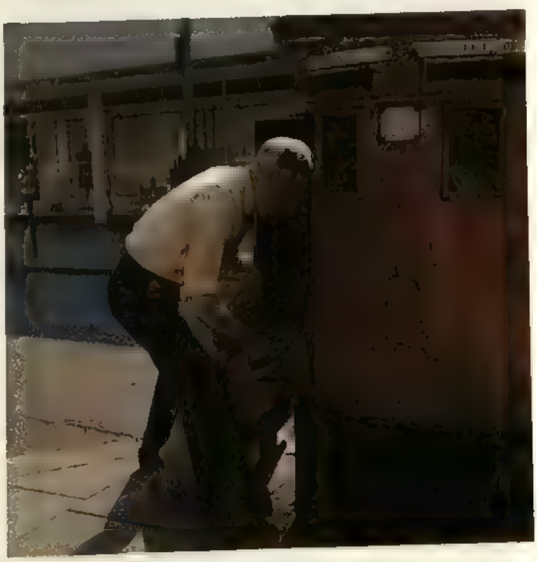
Before the invention of the telegraph and telephone, the postal system was the only reliable means of long-distance communication. It contributed greatly to the growth of developing countries. For example, it enabled businesses and industries to operate more efficiently and to expand, and made possible the development of newspapers and magazines. The postal service also promoted the growth of democracy by keeping citizens informed about the actions of their government. It helped unite people scattered over vast areas into nations.

The United States has the world's largest postal system. U.S. post offices handle more than 110 billion pieces of mail a year, about half the total volume handled throughout the world.

### How mail is delivered

Posting a letter or package is the first step in a long, complicated process. Many people and machines handle the mail before it reaches its destination. This section of this article describes what happens to mail as it travels through the postal system.

**Collection.** People can post a letter by taking it to a post office or by dropping it into a postbox. Postal work-



**Postal workers** make regular collections of mail that has been put in postboxes, such as the one above, in London.

**Automatic sorting** of letters is done on a large scale in a main post office. The sorting machines read the *postcode* (part of the address) on each envelope before sorting it.

ers collect letters and small packets from postboxes and all categories of mail from post offices. They take the mail to *sorting offices,* where it is sorted.

**Sorting.** Many sorting offices use machinery to sort letters. Postal workers in these sorting offices empty the mail sacks onto moving conveyor belts. The belts carry the mail to a machine that sorts it according to envelope size.

The letters then move into another machine with sensing devices that determine where the stamp is located on the envelope. These sensors enable the machine to arrange the letters so they all face in the same direction. The machine cancels the stamp by printing lines over it so it cannot be used again. The machine also prints a postmark on the envelope. The postmark includes such information as the date, and the time and place of posting.

In the most modern postal systems, a sophisticated electronic machine sorts the postmarked letters according to their destination by reading the *postcodes* or *zip codes* (sets of letters and/or numbers that form part of postal addresses in many countries). Each letter is sorted into one of hundreds of bins. Each bin holds mail for a different destination. Letters addressed to locations outside the delivery area served by the local sorting office are transported by truck, train, aeroplane, or boat to a sorting office at their destination, where they are re-sorted for local delivery. Postal workers hand-sort the mail for the local delivery area into bundles for each delivery route.

In some countries, advanced computerized machines called *optical character readers* "read" the postcode on a letter and then pass it on to another machine. The second machine sprays a series of marks known as a *bar code* onto the envelope. Other machines called *bar code readers* then read the code and sort the letter according to its destination.

Some post offices offer high-volume mailers, such as magazine publishers and mail-order companies, the facility to send their mail directly to a bulk mail centre. Bulk mail centres are almost completely mechanized. Conveyor belts carry the sacks of mail to and from the postal trucks. Other machines empty and fill mail sacks. Computerized machines enable postal workers to sort the mail quickly by pushing buttons on a keyboard. Mail addressed to locations outside the bulk mail centre's region is transported to the appropriate centre for processing.

**Delivery.** At the local post office, postal workers receive the mail for businesses and homes along their routes. They arrange the mail in the order it will be delivered. Sometimes, the mail has already been sorted according to the sequence in which it is to be delivered.

Many delivery workers walk their route, though some drive vans, or ride bicycles.

In some countries, mail is delivered differently in towns and rural areas. In towns, the letters are delivered directly to the addressee. In rural areas, however, the post office may deliver direct only if roads are passable. Mailboxes are placed along the road on which the mail is carried.

*General delivery* is used by people without a permanent address. They can have their mail sent to general delivery at a particular post office. They must notify the post office in advance. The post office holds the mail for a limited period of time, or until the addressee calls for it.

### Classes of mail

In many countries, the postal service divides domestic mail into classes. *First-class* mail costs the most, but the post office offers a next-day delivery in most cases.

*Second-class* mail costs less, but takes longer. Newspapers, magazines, and other printed matter can usually be sent at a special rate. Postal services in most countries also handle parcel delivery. Parcels are received by a post office, but may be delivered by a special organization within the postal service.

**Postal workers sort** the letters by hand for local delivery. The letters are arranged in the order in which they are to be delivered.

## Post office services

**Stamps and other postal materials.** Stamps are placed on packages and letters as proof that the sender has paid for posting them.

At various times during the year, post offices issue special stamps called *commemorative stamps.* Some commemoratives honour distinguished people who have died. Other commemoratives pay tribute to historic events, places of scenic beauty, important industries, or outstanding organizations.

Post offices also sell air letters. Air letters are lightweight sheets of paper that can be folded to form an envelope. The inside of the air letter contains the sender's message, and the postage is printed on the outside.

**Speedier delivery.** Several special services enable customers to send mail faster than normal. The sender must pay an extra fee for these services, which include *special delivery.*

Special delivery mail is processed and delivered as soon as it arrives at the post office. In most cases, special delivery mail is delivered by a special messenger instead of by a regular delivery worker.

**Extra protection.** Some mail services enable postal customers to obtain special protection for the items they send through the post. Other services enable them to obtain proof of posting and delivery. Customers must pay an extra fee for these services, which include *insurance* and *registration.*

Insurance pays compensation to cover the value of items lost or damaged in the post.

Registration provides special protection for irreplaceable items. The addressee must sign a receipt before the item will be delivered.

**Specialist services.** In many countries, the post office provides a range of specialist services, apart from delivering letters. For example, the Datapost service that is run by the Post Office in the United Kingdom is a courier service that offers delivery to more than 90 countries. It guarantees rapid delivery of packages and provides insurance cover against loss or damage. Such services have helped post offices compete against private carriers offering a similar service.

Another service that is provided in a number of countries, including Australia, the UK, and the United States, is a public *fax* (facsimile transmission) service. The service is called *Intelpost* (which stands for International Electronic Post). Messages are converted into electronic signals, and travel along telephone lines to receiving units in destination post offices, where they are printed and delivered. Such services use undersea cables and satellites to relay messages between continents. See **Facsimile.**

Other specialist services offered by post offices in some countries include COD and the acceptance of metered, or franked, mail. COD, which stands for *cash on delivery* (or, in the United States, *collect on delivery*), enables people to order merchandise by mail and pay for it when it arrives. The delivery worker collects the price of the item plus postage and a COD fee. Use of the COD service has declined since the introduction of credit cards and the possibility of paying for merchandise by quoting one's credit card number over the telephone.

Franked mail is mail that has the postage and postmark printed directly onto it (in the case of letters) or onto an adhesive strip that is stuck down onto the postal item using a franking machine. Companies buy or lease franking machines from the post office or from an authorized manufacturer. Postage is paid for in advance by the company as and when needed, the amount being set on the franking machine by a postal employee.

**Other services.** In addition to postal and telecommunications services, some post offices offer their customers additional services. In most countries, post offices sell *postal orders* and/or *money orders,* which resemble cheques and provide a safe way to send money by post (see **Postal order**). Some national post offices run savings schemes and provide a full banking service.

**Post offices** offer a variety of services to customers. A post office counter like this one in Madagascar sells stamps, air letters, and postal orders, and receives items for posting.

The governments of some countries use post offices to pay old-age pensions, pensions for blind and disabled people, and a number of other welfare benefits. Some post offices serve as the place of registration of foreigners resident in the country concerned. Application forms for passports and driving licences may be obtained from post offices in many countries.

### Postal systems worldwide

Nearly all industrial countries and some developing countries have efficient postal systems. In the United Kingdom, for example, there are about 1,500 main post offices. British postal workers deliver to more than 23.5 million addresses, and handle more than 14 billion letters and small packets, and 200 million parcels every year. In Australia, there are about 4,800 post offices, which handle about 3 billion postal articles each year. New Zealand has about 1,300 post offices, which handle about 700 million items a year. There are about 140,000 post offices in India. The Philippines has more than 2,000 post offices.

In some developing countries, there are few post offices, and mail delivery is slow and unreliable. In some cases, only urban areas have a postal service. An agency of the United Nations called the Universal Postal Union promotes international cooperation in the delivery of mail.

### History

**Ancient times.** Many ancient civilizations, including the Chinese, Egyptians, Assyrians, and Persians, had well-organized postal systems. These early postal networks existed to help rulers govern empires that stretched over large areas. Only government officials could use the postal system. However, there was little demand for public postal service because few people could read or write.

Nearly all ancient postal systems were *relay systems*. They consisted of runners or mounted couriers stationed at intervals along major roads. Messages relayed by these couriers travelled swiftly, sometimes more than 150 kilometres a day. Herodotus, a Greek historian of the 400's B.C., described the Persian messengers by writing, "Neither snow/ nor rain/ nor heat/ nor gloom of night stays these couriers from the swift completion of their appointed rounds."

The most highly organized postal system of ancient times was established by Augustus Caesar, who became the Roman emperor in 27 B.C. It was a relay system in which mounted couriers rode throughout the empire on a network of well-constructed roads. Along the roads, the Romans built relay stations called *posthouses*. There, messengers could rest, get fresh horses, or pass their messages to another courier. In the A.D. 200's, Roman couriers began to deliver a limited amount of private mail as well as official messages.

The fall of the Western Roman Empire in the A.D. 400's led to the collapse of the postal system. Rulers in some areas continued to use Roman roads and posthouses for their own postal services. Generally, however, organized communication ended throughout western Europe.

Civilizations in other areas of the world also developed efficient postal systems. In Asia, the Mongol leader Kublai Khan developed a highly organized postal relay system, with more than 10,000 postal stations, during the 1200's. In North and South America, the Aztec and the Inca established networks of relay runners, who delivered messages and packages between major cities.

**The beginning of public postal systems.** During the 1300's, the growth of international commerce led merchants and trading companies to establish their own courier services. Universities, religious groups, and *guilds* (organizations of skilled workers) also maintained a postal service for their members. However, service was slow, expensive, and unreliable.

The invention of the printing press and the growth of education and learning during the 1400's increased the demand for postal systems. Delivering mail became a profitable business, and private postal services sprang up in many areas. By the 1500's, such systems crisscrossed Europe. The Taxis family of Vienna organized one of the most famous private systems. By the early 1600's, their service employed about 20,000 couriers and covered most of central Europe. Generally, however, service remained costly and slow. In addition, deliveries were made only along major transportation routes.

The rise of strong national governments in Europe in the late 1400's and the 1500's led to the establishment of official postal services. In 1477, King Louis XI of France created a postal system of mounted couriers with regular schedules.

In the late 1400's, King Edward IV of England set up a system of *posts* (stations) where fresh horses were kept for the messengers who carried his dispatches. Later, the word *post* gradually came to be used in reference to the whole business of handling mail.

In about 1516, King Henry VIII of England appointed Sir Brian Tuke as Master of the Posts, mainly to ensure that the royal mail was delivered speedily and safely. Sir Brian planned four roads from London. The 110-kilometre road from London to Dover was the best of these roads.

During the early 1600's, the growing popularity of official postal systems and the profits earned by private couriers led many European governments to establish public postal systems. In addition, many governments wished to use the postal system to spy on their citizens for evidence of disloyalty to the state. In 1627, the French government established post offices in major cities and fixed postal rates. In 1635, the English government established a public postal system between England and Scotland.

Many countries passed laws giving the government the sole power to provide postal delivery. However, private postal services continued to operate in these countries, mostly along routes not covered by government postal systems.

**Development of the postal system.** In 1680, a merchant named William Dockwra organized the London Penny Post, which delivered mail anywhere in London for a penny. Dockwra introduced the practice of postmarking letters to indicate when and where they had been posted. The London Penny Post became so successful that the government took control of the operation in 1682.

During the 1700's, a programme to improve the condition of public roads in Great Britain (now the United Kingdom) greatly increased the speed at which mail travelled. In 1784, John Palmer introduced mail coaches. The first mail coach, which travelled from Bristol to London, completed the 190-kilometre journey in 16 hours. The mail was first carried by rail from Liverpool to Manchester in 1830.

In 1837, a retired British schoolteacher named Rowland Hill wrote a pamphlet calling for cheap, uniform postage rates, regardless of distance. At that time, the cost of sending a letter depended on how far it had to travel. Hill also proposed that postage should be paid in advance by the sender, with adhesive stamps to indicate payment. Previously, the letter carrier collected postage from the addressee unless postal officials had written "Paid" on the letter. In addition, Hill suggested the use of envelopes. Until that time, letters were merely folded and sealed with sealing wax. Most of Hill's suggestions were adopted in the UK in 1840, when the first adhesive postage stamps were issued. They were called *penny blacks,* because they were printed in black ink.

**A penny black**

Australia's official postal services began on April 25, 1809 when Isaac Nichols was appointed postmaster of the colony of New South Wales. His home in Sydney became the first post office. Governor Hobson set up New Zealand's first post office in Kororareka (now Russell) in 1840. Australia's first postage stamps were issued in 1850 and New Zealand's in 1855.

**During the 1800's and early 1900's,** postal services grew rapidly. The development of modern means of transportation, such as trains, improved the speed and reliability of mail delivery. Postal clerks sorted mail on special railway carriages while the trains moved across the country. Devices called *catching arms* attached to the carriages enabled the clerks to pick up mail sacks from small towns as the trains sped by. The clerks tossed sacks of letters for the town onto the railway platform from the moving train.

The number of post offices grew rapidly. In 1789, the United States had about 75 post offices. By 1901, the number of post offices had increased to almost 77,000.

The British Post Office continued to improve and extend its services. In 1853, it introduced the first postboxes. In 1855, it first installed postboxes in London. The Post Office Savings Bank was begun in 1861, and private telegraph services were taken over by the Post Office in 1870.

**The growth of airmail service.** The use of aeroplanes to carry mail has greatly increased the speed of delivery.

Mail was carried unofficially by Claude Grahame-White, a British pilot, in 1910, on a flight from Blackpool to Southport, in England. In 1911, a French pilot, Henri Pequet, carried mail from Allahabad to Naini Junction in India, and a regular airmail service was set up. Mail flights in the United Kingdom and the United States also began in 1911. Airmail services in Australia began in the 1920's. The first airmail flight between Australia and the UK took place in 1934.

**Recent developments.** Post offices in industrial countries have followed a policy of providing more automation in the handling of mail to provide customers with a better service. Postage rates have risen, as governments have increasingly insisted that post offices become self-supporting. Private firms are not normally allowed to handle ordinary mail, although there has been an increase in the number of private carriers of circulars, catalogues, magazines, and merchandise samples. Private parcel carriers also compete with the post office.

The growth of electronic postal services has been a major development. In developing countries, the postal service is being extended to rural areas, and modernized to take advantage of new technological developments. Many small nations earn valuable income from the issue of commemorative stamps, valued by stamp collectors. However, delivery of letters remains the main job of post offices and postal workers around the world.

**Related articles** in *World Book* include:

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Postal order
Postal Union, Universal
Stamp collecting

**Outline**

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**Postage stamp.** See **Post office** (Stamps and other postal materials); **Stamp collecting.**

**Postal order,** or money order, is a document ordering that a sum of money be paid to a certain person. A purchaser buys the postal order at a post office and keeps a *counterfoil* to prove its value and the date of purchase. Only the person named on the order can cash it. If the postal order is lost, the purchaser can submit the counterfoil to the post office for a replacement.

A postal order provides a safe way of sending money to another person without risk of loss or theft. It is convenient if either person does not have a bank account and therefore cannot write or cash a cheque.

Postal orders can be cashed at post offices or banks. They are not negotiable instruments (see **Negotiable instrument; Post office**).

**Postal Union, Universal (UPU),** is a specialized agency of the United Nations that sets rules for the free flow of mail between countries. It works to promote international cooperation in organizing and improving postal services. The UPU provides technical assistance to its approximately 170 member countries, which constitute a single postal territory for exchanging mail.

The UPU operates under an international agreement called the Universal Postal Convention. The convention lists postal rates and uniform procedures for handling first-class mail, including letters, postcards, and small packets. Under the convention, member countries set postal charges within specified limits. If a country's postal service receives a greater number of mail items than it sends, it is entitled to collect the cost of handling this excess mail from the sender country. Separate agreements govern other services, such as parcel post, newspaper and magazine subscriptions, insured letters and boxes, and money orders.

The *Universal Postal Congress* is the main legislative body of the UPU. It usually meets every five years in a member country to review and amend the convention. UPU legislation takes precedence over any conflicting national laws. However, some provisions are optional.

The *Executive Council* is a permanent body that handles UPU affairs between congresses. It consists of 40 members, elected on the basis of geographical representation. The *Consultative Council on Postal Studies* conducts technical research in international postal matters. This council has 35 members. The *International Bureau* is the UPU's permanent secretariat. The International Bureau may also act as an information centre and clearinghouse for settling the financial accounts of the UPU.

The first international postal congress was held by 22 countries in 1874 in Bern, Switzerland. The first postal convention went into effect in 1875. The UPU received its present name in 1878 at the second postal congress. The UPU became a specialized agency of the United Nations in 1947. The permanent headquarters of the Universal Postal Union is in Bern.

**Poster** is a printed sheet of paper or cardboard that is displayed in public. Most posters convey a simple message that combines words with illustrations. Posters may announce events such as plays, films, or art exhibitions. They may also advertise commercial products or political messages.

A typical poster emphasizes simple shapes, bright colours, and large letters to attract attention. Most posters are large enough to be seen from a distance. They are often posted on walls and places along streets where the public can easily see them. Many posters are so large that they are placed on hoardings. Commercial posters are usually made by photography, lithography, or silk-screen printing.

Designing posters became popular with European artists in the 1800's. Beginning about 1866, the French artist Jules Chéret produced more than 1,000 large colourful posters using the recently invented process of colour lithography. In the 1890's, the French artist Henri de Toulouse-Lautrec gained fame for the beautiful bold designs of the posters he made for theatres and dance halls. A number of artists in the 1900's have designed posters that are collected as works of art.

See also **Advertising** (Outdoor signs); **China** (Communication; picture: Wall posters); **India** (picture: Huge cinema hoardings); **Poland** (picture: A huge poster); **Propaganda** (pictures); **Uncle Sam** (picture).


**A French poster** by Henri de Toulouse-Lautrec advertises a music hall appearance by performer Aristide Bruant in 1893.

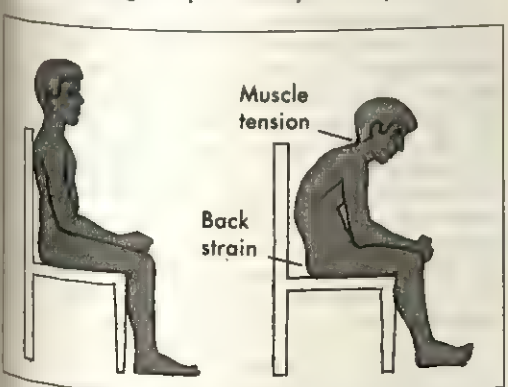
**Postimpressionism.** See **Impressionism.**
**Postulate.** See **Geometry** (Axiomatic organization).
**Posture** is the position of a person's body while standing or sitting. Posture is determined by the person's ability to maintain balance against the force of gravity, which constantly pulls the body downward. The action of certain muscles keeps the body upright. These muscles include those that keep the back, hips, and knees from bending. Because of the constant give and take of the pull of gravity and of muscle action, posture is a dynamic, ever-changing state. It is impossible for a person to stand perfectly still, because there is always some degree of sway. If postural control is inadequate, the sway becomes excessive and the person loses balance.

Good posture requires the least amount of muscle activity to breathe well and to maintain an upright position. The feet should be placed comfortably apart, with the weight distributed evenly over both feet. From a front or back view, the shoulders, hips, and fingertips should be approximately aligned. From a side view, the ear and the shoulder should be aligned, and that line projected downward should fall in front of the middle of the knee. The back should not be excessively arched. The arches of the feet should be visible without conscious effort.

Sitting posture is important. Many people develop back problems because they often sit badly, hunched over a desk or table, or over the steering wheel of a car. Slouching in a chair is more tiring than sitting upright, because it causes needless strain and muscle tension. For good sitting posture, the body should be positioned well back in the chair, with the limbs aligned and the feet flat on the floor.

Posture is an indication of the way people have stood or sat for much of their lifetime. If a person constantly stands or sits with the head hanging forward, the neck muscles change in length, and good posture becomes difficult. Because all body parts work together, getting one part, such as the head, out of alignment will cause other body parts also to be out of alignment. The further away one's body parts are from the body's centre of gravity, the more the muscles will have to work to keep the body upright. This results in fatigue and stress.

Posture also may indicate the way people feel. If they are tired or depressed, their posture may be poorer than usual. Changes in posture may affect a person's appearance, gait, and personality. Good posture gives an impression of poise and self-confidence, and may allow the body to function at its best. Learning about body function and body relaxation can help improve posture.



**Posture** can be good or bad. Good posture, *left,* requires the least amount of muscle activity. Bad posture, *right,* results in muscle tension and back strain.

**Pot,** a drug. See **Marijuana.**
**Potash** is the commercial name for a group of salts containing the element potassium. The most important type of potash is *potassium chloride* (KCl), which is mainly used to make fertilizer. About 95 per cent of the potash that is processed throughout the world is refined for fertilizers. Potash is also used in the manufacture of soaps and detergents, glass, ceramics, textiles, dyes, chemicals, and drugs.

The mineral sylvite is the chief potash ore. Most potash ore is found in underground salt beds that formed when ancient seas evaporated. The deposits are usually obtained by a method of mining called the *room-and-pillar* system (see **Mining** [Underground mining methods]). Potash also occurs in salt lakes. Potash is graded according to its *potassium oxide* ($K_2O$) *equivalent,* a standard that measures potassium content. The $K_2O$ equivalent is also used to determine how much potash a mine will produce.

Potash was originally obtained by running water through wood ashes and boiling the resulting solution in large iron pots. The substance that formed, *potassium carbonate* ($K_2CO_3$), was called *pot ash.*

See also **Potassium.**
**Potassium** is a chemical element with symbol K. It is a silvery metal. It reacts readily with both oxygen and water. With oxygen it, forms potassium monoxide ($K_2O$) and potassium peroxide ($K_2O_2$). In nature, because of this characteristic, potassium always occurs combined with other elements. It is found in the form of minerals, such as carnallite and sylvite. Sir Humphry Davy, an English chemist, first isolated potassium as a pure metal in 1807.

Potassium is the second lightest metal after lithium. It is so soft that it can be cut with a knife. Potassium has an atomic number of 19 and an atomic weight of 39.0983. Potassium belongs to the group of elements called *alkali metals* (see **Element, Chemical** [Periodic table of the


**Potash** is the commercial name for potassium chloride, *foreground,* and several other salts that contain potassium. Most potash is obtained from the mineral sylvite, *background.*

elements]). It melts at 63.2° C and boils at 766° C. At 20° C, it has a density of 0.856 gram per cubic centimetre (see **Density**). One isotope of the element, potassium-40, is radioactive. The age of a substance can often be determined by analysing the amount of potassium-40 it contains.

Potassium is a relatively abundant element and makes up nearly 2½ per cent of the earth's crust. Large deposits of its principal compounds, including potassium chloride and potassium sulphate, occur in parts of Canada and Germany. The Dead Sea is another major source of potassium compounds.

Scientists have developed a wide variety of uses for potassium and its compounds. Potassium metal, used chiefly in sodium-potassium alloys, is usually obtained from molten potassium chloride through a special chemical process. These alloys, which are liquids at room temperature, are used in the heat-transfer systems of some types of nuclear reactors called *fast breeders.* Manufacturers use potassium carbonate, also called *potash,* in making certain kinds of glass and soaps. They use potassium nitrate, known as *saltpetre,* in producing matches and explosives. Some potassium compounds are used for medical purposes. For example, potassium bromide is a sedative, and potassium iodide promotes the discharge of mucus from the nose and throat.

Plants require potassium for growth. Therefore, soil must contain potassium compounds to produce crops of high quality and yield. Potassium chloride is widely used in commercial fertilizers for most crops. But potassium sulphate is a better fertilizer for tobacco and crops that would be harmed by potassium chloride.

Potassium also is essential for human beings and other animals. It plays a part in *metabolism,* the process by which organisms change food into energy and new tissue. For example, potassium helps enzymes speed up some chemical reactions in the liver and the muscles. Such reactions produce an important carbohydrate called *glycogen,* which regulates the level of sugar in the blood and helps provide energy for the muscles. Potassium, together with sodium, also contributes to the normal flow of water between the body fluids and the cells of the body. A daily diet that includes fruit, vegetables, and meat supplies enough potassium for the normal needs of the human body.

See also **Alkali**; **Fertilizer** (Mineral fertilizers); **Potash**; **Saltpetre**.

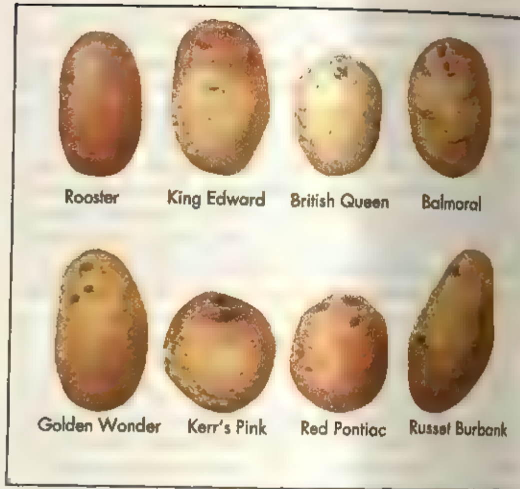
**Potassium-argon dating.** See **Archaeology** (Dating).

**Potassium nitrate.** See **Saltpetre**.

**Potato** is the world's most widely grown vegetable and one of the most important foods. Potatoes have a high nutritional value and are grown in most countries.

Potatoes are prepared in various ways—baked, boiled, fried, and mashed—and are served with meat or fish and with other vegetables. Food processors make potatoes into instant mashed-potato powder, and other products. Food canners use potatoes in such foods as soup and stew. Other products whose ingredients may include potatoes are alcoholic beverages, flour, and certain starches used in industry.

A potato consists of about 80 per cent water and 20 per cent solid matter. Starch makes up about 85 per cent of the solid material, and most of the rest is protein. Potatoes contain many vitamins, including niacin, riboflavin, thiamine, and vitamin C. They also contain such minerals as calcium, iron, magnesium, phosphorus, potassium, sodium, and sulphur.




**Potatoes** are one of the most important and nutritious foods. They may be prepared in many ways. Some of the most popular of the several hundred kinds of potatoes are shown above.

Potatoes are not especially fattening unless flavoured with butter, gravy, or sour cream. An average-sized baked potato that weighs from 170 to 225 grams contains fewer than 100 calories.

Potato growers often weigh potatoes in 45-kilogram units called *bags.* Growers throughout the world produce a total of about 270 million metric tons of potatoes annually. Until its breakup in 1991, the Soviet Union grew about 25 per cent of the world's potatoes, more than any other country, followed by Poland, China, and the United States, in that order.

Hundreds of different kinds of potatoes are grown throughout the world. In most industrial countries, however, about 10 varieties account for up to 80 per cent of the annual production of potatoes. The potato—also known as the common, or Irish, potato—is one of the most widely grown vegetables. It was introduced into Europe from South America by Spanish explorers in the mid-1500's. In the Netherlands and the United States, the most widely grown varieties continue to be the old ones. Bintje, in the Netherlands, was introduced in 1910. Russet Burbank, in the U.S.A., was introduced before 1890. In the United Kingdom, the King Edward VII potato, introduced in 1902, remains popular. Until the 1970's, "King Edwards" and the Majestic were the only two main crop varieties of outstanding importance in the United Kingdom. Since the 1970's, Pentland Crown and Maris Piper, two newer varieties, have become popular. But in Germany, 9 of the 10 most popular varieties were developed during the 1950's and 1960's.

### The potato plant

The edible parts of a potato plant are growths called *tubers,* which form underground on the stems. Most potato plants have from 3 to 6 tubers. Some have from 10 to 20, depending on the variety, the weather, and soil

conditions. Potatoes are round or oval and rather hard. They may grow more than 15 centimetres long and may weigh as much as 1.5 kilograms. Their skin is thin and may be brown, reddish-brown, pink, or white. The inside of a tuber is white.

Tubers consist of several layers of material. The outer skin is called the *periderm.* The next layer, the *cortex,* serves as a storage area for protein and some starch. The third layer, known as the *vascular ring,* receives starch from the plant's leaves and stem. The starch moves out of the vascular ring to surrounding tissue made up of *parenchyma cells.* These cells are the tuber's main storage areas for starch. The centre of the tuber, called the *pith,* consists mostly of water.

The part of the plant that grows above ground has spreading stems and coarse, dark green leaves. The potato plant grows from about 90 to 120 centimetres tall. It has pink, purple, or white flowers that appear three or four weeks after the plant starts to grow above ground.

The flowers of potato plants develop seedballs that resemble small green tomatoes. Each seedball contains about 300 yellowish seeds. Scientists use these seeds in developing new varieties of potato plants.

### Growing potatoes

**Planting and cultivating.** Potatoes must be replanted annually, generally in spring, because the plants die after the tubers mature. Potato plants grow best in areas where the temperature usually ranges between about 15° and 20° C.

Most potato growers plant small, whole tubers and segments called *seedpieces,* which weigh about 40 grams and are cut from tubers. The whole tubers and the seedpieces are both known as *seed potatoes.* Each seed potato has at least one *eye* (bud) from which the stems grow both above and below the ground. Whole tubers are the best seed potatoes because they are less likely to rot and become diseased than seedpieces. Before planting seed potatoes, farmers spray them with fungicides to reduce the possibility of disease.

Commercial potato growers use machines that plant up to six rows of seed potatoes at a time. The seed potatoes are planted from 5 to 10 centimetres deep and 15 to 50 centimetres apart. The rows are planted from 75 to 90 centimetres apart. Potato growers plant about 1.5 to 3 metric tons of seed potatoes per hectare.

Potatoes grow best in *loam,* a type of soil whose texture varies between that of clay soil and sandy soil. The loam should be *aerated* (mixed with air), well-drained, and enriched with fertilizer. Farmers occasionally cultivate the soil around the growing plants. Cultivation helps aerate the soil, kill weeds, and supply soil covering for the growing tubers. Potato growers use two basic methods of cultivation, *ridge, or hill, culture* and *level culture.*

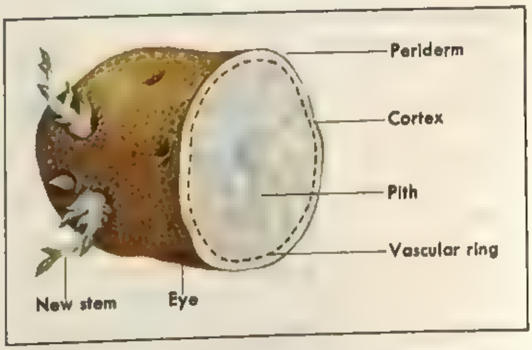
Ridge culture is the most common method of cultivation. Farmers use a cultivator to build small hills over the seed potatoes. The hills, which stand from 15 to 20 centimetres high, protect the tubers from sunburn or frost.

Level culture is used mostly in areas where growers plant the seed potatoes deep in the soil. They are planted in a deep furrow, which the farmer gradually fills as the plants grow.

After the flowers drop off a potato plant, some farmers spray the leaves frequently with chemicals to prevent the tubers from sprouting after being harvested. Farmers sometimes destroy the leaves before the plants reach maturity. The farmers do this so they can harvest the potatoes before frost or disease hits the plants.

**Harvesting.** Most commercial potato growers use potato combines to harvest their crop. These machines dig the plants out of the ground, separate the tubers from the soil, and load the potatoes into trucks. The combines dig up two to four rows at a time.

**A potato plant** has leafy stems and pink, purple, or white flowers. From 3 to 20 growths called *tubers* form underground on the stems. The tubers are the edible parts of the plant.




**A cross-section of a potato** shows several layers of material. Each layer serves a function essential to the proper growth of the plant. Stems sprout from the eye of a tuber.

**A potato combine,** *above,* digs up potato plants and separates the tubers from the soil. The potatoes are loaded automatically into a truck and taken to a packing shed. Then they are washed and packed for shipment or stored in warehouses.

The potatoes are collected and then taken to a packing shed to be washed and packed for shipment. Bruised or diseased potatoes are discarded, and the rest are graded according to size. Some potatoes are shipped directly to food-processing plants or to supermarkets. But most potatoes are stored for some time in warehouses at temperatures ranging from 4° to 10° C. The stored potatoes can be marketed as long as a year after being harvested.

**Diseases and insect pests.** Several diseases may attack potato crops. They include such fungus and bacterial diseases as *late blight, rhizoctonia, ring rot,* and *scab* and such virus conditions as *leafroll, mosaic,* and *spindle tuber.*

Late blight is controlled by spraying or dusting the plants with certain fungicides. Rhizoctonia and scab may be partially controlled by planting healthy seed potatoes. Ring rot can be controlled only by the use of disease-free seed potatoes. Virus diseases are best controlled by removing any diseased plants or tubers from the field and by using healthy seed potatoes.

The chief insects that attack potato plants include *aphids, flea beetles, leafhoppers, Colorado beetles,* and *potato psyllids.* The tubers are attacked by various insects, including *cutworms, grubs, potato tuber worms,* and *wireworms.*

Insects that feed on potato plants can be controlled by spraying insecticides into the furrow at planting time. The roots absorb the insecticides and transport them to the stems and leaves. The pesticides kill insects that feed on the leaves. Other insecticides may be sprayed directly on the leaves. Insects that attack the tubers are controlled by spraying insecticides into the soil before planting.

**Leading potato-growing countries**


Figures are for 1990.
Sources: Food and Agriculture Organization of the United Nations; U.S. Department of Agriculture.

## History

The potato originated in South America. Most botanists believe the potato comes from a species that first grew in Bolivia, Chile, and Peru. More than 400 years ago, the Inca Indians of those countries grew potatoes in the valleys of the Andes Mountains. From the potatoes, the Inca made a light, floury substance called *chuño.* They used chuño instead of wheat in baking bread.

Spanish explorers in South America were the first Europeans to eat potatoes. The Spaniards introduced them into Europe in the mid-1500's. About the same time, English explorers brought potatoes to England. From there, potatoes were introduced into Ireland and Scotland. They became the principal crop of Ireland because they grew so well there. In fact, the potato became known as the *Irish potato* because such a large part of the Irish population depended on it for food.

Potatoes were probably introduced into North America in the early 1600's. However, they did not become an important food crop until after Irish immigrants brought potatoes with them when they settled in New Hampshire in 1719.

From 1845 to 1847, Ireland's potato crop failed because of late blight. As a result, about 750,000 Irish people died of disease or starvation. Hundreds of thousands of others left Ireland and settled in other countries, chiefly the United States.

During the 1900's, the development of food processing has resulted in a tremendous use of potatoes in making such products as chips and potato crisps.

**Scientific classification.** The potato belongs to the nightshade family, Solanaceae. It is *Solanum tuberosum*.

**Related articles** in *World Book* include:

| | | |
|---|---|---|
| Burbank, Luther | Nightshade | Sweet potato |
| Colorado beetle | Solanum | Tuber |
| Fungicide | Starch | |

**Potato bug.** See **Colorado beetle.**

**Potato famine.** See **Ireland** (The potato famine).

**Potential energy.** See **Energy.**

**Potentilla** is the name of several types of flowering shrub. Different species of potentillas are found in Europe, Asia, and America. Potentillas are also known as cinquefoils. Varieties of the potentilla known as *bush cinquefoil* grow easily almost anywhere, and are also cultivated as garden plants. These have yellow, red, orange, or white flowers, and grow to between 50 centimetres and 1.5 metres tall.

**Scientific classification.** Potentillas belong to the family Rosaceae. Bush cinquefoil is *Potentilla fruticosa*.

**Potentiometer** is a device that measures electric current, voltage, and resistance with high precision. It shows voltage differences by comparing an unknown electromotive force with a known one. It is used to calibrate voltmeters and ammeters, and as a control element in electronic circuits and devices.

See also **Ammeter; Voltmeter.**

**Potsdam** (pop. 138,737) is a German city that stands on the Havel River, about 24 kilometres southwest of Berlin. For location, see **Germany** (political map). Potsdam's leading economic activities include engineering and the production of chemicals, processed foods, and textiles. Flower growing is also an important industry in the city. Broad squares and public gardens add to the city's beauty.

See also **Potsdam Conference.**

**Potsdam Conference** was the last meeting among the leaders of the Soviet Union, the United Kingdom (UK), and the United States during World War II (1939-1945). The conference was held at Potsdam, near Berlin, Germany. It opened on July 17, 1945, about two months after Germany's defeat in the war. Present at the opening were U.S. President Harry S. Truman, British Prime Minister Winston Churchill, and Soviet Premier Joseph Stalin. Clement Attlee succeeded Churchill as prime minister on July 26 and represented the UK for the rest of the conference, which ended on August 2.

Earlier agreements had divided Germany into British, French, Soviet, and U.S. occupation zones. At Potsdam, the participants agreed to treat the country as a whole in economic matters. The Soviet Union received a third of Germany's ships and some industrial equipment as payment for war damages. The participants also agreed to prosecute German leaders for war crimes (see **Nuremberg Trials**). While at Potsdam, Truman learned of the first successful atomic bomb test. That news led to the Potsdam Proclamation, threatening the destruction of Japan unless it stopped fighting the Allied nations and surrendered without conditions.

At Potsdam, the U.S. and British leaders charged that the Soviet Union had helped establish Communist governments in the countries of Eastern Europe that it had freed from German control. This criticism clearly showed a serious division among the members of the wartime alliance.

See also **Churchill, Sir Winston; Stalin, Joseph; Truman, Harry S.**

**Potter, Beatrix** (1866-1943), was an English author and illustrator known for her charming children's stories about small animals. Her books combine stories of adventure and humour with delicate watercolours that capture the action and mood of the text. Potter's first and most famous story is *The Tale of Peter Rabbit* (1902).

**A watercolour by Beatrix Potter** helped bring to life *The Tale of Peter Rabbit*, her first animal story for children. Potter based her delicately coloured paintings on the landscapes and small animals she observed near her home in northern England.

Potter wrote and illustrated about 25 books. In addition to Peter Rabbit, her characters include Squirrel Nutkin, Benjamin Bunny, Tom Kitten, Jemima Puddle-Duck, the Flopsy Bunnies, and Pigling Bland.

Helen Beatrix Potter was born in London. She began drawing plants and animals as a child. Potter based many of her illustrations on the animals and rural landscapes of the Lake District of northern England.

See also **Literature for children** (picture: The first modern picture book).

**Potter, Dennis** (1935-1994), a British playwright, author, and journalist, became well known for his television plays. His originality reached a peak in *Pennies from Heaven* (1978), a serial about a music salesman in the 1930's who wants life to be more like the popular songs of his day. Other serials by Potter were *The Singing Detective* (1986), and *Lipstick On Your Collar* (1993). His most famous play was *Brimstone and Treacle* (1976).

Potter was born at Coleford, in Gloucestershire, England. He was educated there, in London, and at New College, Oxford. Despite ill-health, he soon achieved a reputation as a brilliant and creative writer.

**Potter, Stephen** (1900-1969), a British author, became widely known for his humorous books. They include *The Theory and Practice of Gamesmanship, or the Art of Winning Without Actually Cheating* (1947), *Some Notes on Lifemanship* (1950), *One-Upmanship* (1952), *Supermanship* (1958), and *The Magic Number* and *Steps to Immaturity* (1959). He also worked as a producer of radio programmes. Potter was born in London.

**Potteries** is the name given to a district of northern Staffordshire, England, devoted to the manufacture of china and earthenware. Stoke-on-Trent is the chief centre of the pottery industry in England. The names of Wedgwood and Minton have made the Potteries world famous. The pottery industry imports fine clay. Coarse clay and coal are abundant in the area.

See also **Stoke-on-Trent**.

**Chinese pottery** of the Song dynasty (A.D. 960-1279), such as this porcelain vase, ranks among the most beautiful in the world. A grey-green glaze provides the rich colour.

**Potter's field** is a free burial ground for strangers, criminals, and people too poor to pay funeral expenses. The Bible tells of the first plot of ground known as a potter's field. After Judas Iscariot betrayed Jesus Christ to the high priests of Jerusalem for 30 pieces of silver, he returned the money to the priests. They would not use the money for their Temple. Instead they bought "the potter's field to bury strangers in" (Matt. 27: 7). The field has been located in the Valley of Hinnom because this has an ancient long-used cemetery, and clay for making pottery.

**Pottery** is a type of decorative or useful ware made of baked clay. It ranges from valuable works of art created by professional potters to ashtrays and other simple items made by amateurs. In addition, pottery includes dinnerware, vases, and other household items. The word *pottery* also means a factory that makes pottery.

A piece of pottery may be mass-produced, or it may be the only one of its kind. Since ancient times, potters have shaped and *fired* (baked) clay to make pottery. Some pottery in museums is thousands of years old and still in good condition.

Pottery belongs to a large group of items called *ceramic products*. Such products are made from materials known as *ceramics*. Ceramic products, in addition to pottery, include bricks, cement, grinding tools, sewer pipes, and other products used in industry. For more information on the products and processes of the ceramics industry, see the *World Book* article on **Ceramics**.

## Types of pottery

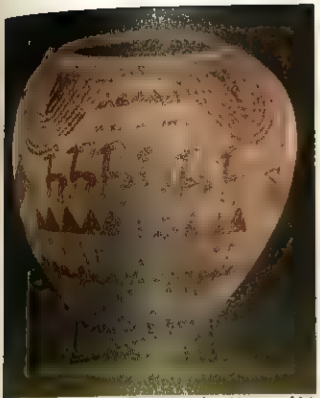
The three major types of pottery are (1) earthenware, (2) stoneware, and (3) porcelain. Pottery is classified according to the mixture of clays that it contains and the temperature at which the mixture is fired. The firing temperature affects both appearance and strength.

**Earthenware** is a widely used type of pottery made largely from a mixture of earthenware clays. Such clays are found in soil in all parts of the world. Many people prefer earthenware because of the colourful *glaze* (glassy coating) that is applied to it. This pottery, like most pottery with bright, colourful glazes, is baked at a low temperature. Other types of pottery are less colourful because they are fired at a high temperature, which harms most colourful glazes. Earthenware breaks and chips more easily than other types of pottery.

**Stoneware** is a hard, heavy kind of pottery made mostly from a mixture of stoneware clays. Potters fire such clays at extremely high temperatures. The heat causes the surface of stoneware to become glossy, and so many potters do not glaze it. Stoneware is stronger and heavier than earthenware. Like earthenware and some kinds of porcelain, it is *opaque*— that is, light cannot shine through it.

**Porcelain** is the purest and the most delicate type of pottery. There are two types of porcelain. *Hard paste porcelain* is fired at high temperatures. *Soft paste porcelain*, which includes chinaware, is fired at lower temperatures.

Potters make porcelain from a mixture that includes flint, a mineral called *feldspar*, and large amounts of kaolin. Kaolin is a fine, white clay, and so most porcelain fires to a delicate shade of white. Light can shine through a thin piece of porcelain. See **Kaolin**; **Porcelain**.



The Metropolitan Museum of Art, New York City

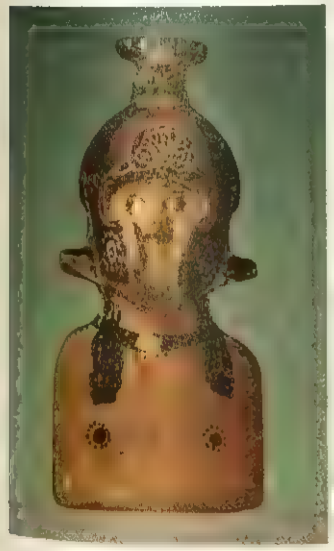
**An Egyptian earthenware bowl,** made between 3200 and 3000 B.C., shows an arrangement of animals and hills.

The Museum of Ife Antiquities, Ife, Nigeria

**An African terracotta head** honours a ruler of the old kingdom of Ife, in Nigeria. It was created in the A.D. 1100's.

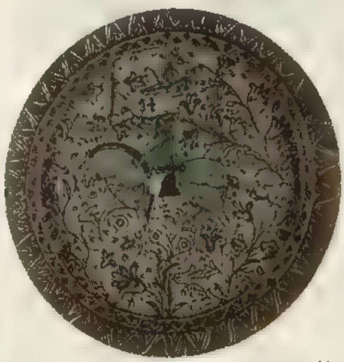
Dyson Perrins Museum, Worcester, England

**An English porcelain teapot** of about 1760 had a design strongly influenced by Chinese porcelain.



The Metropolitan Museum of Art, New York City

**A small Greek flask** of the 500's B.C. held cleansing oils. The terracotta flask was carried on a wrist strap.



The Metropolitan Museum of Art, New York City

**An Italian majolica dish** of the A.D. 1400's was decorated with detailed designs and covered with a white glaze.

**A contemporary vase,** made of white stoneware, consists of four vases of different sizes that form a unit.

## How pottery is made

There are four basic steps in making pottery: (1) preparing the clay, (2) shaping the clay, (3) decorating and glazing, and (4) firing.

**Preparing the clay.** Potters prepare clay by pressing and squeezing it with their hands or by mechanical methods. This treatment makes clay soft and smooth, and it eliminates air bubbles that could cause the clay to crack during the firing process.

**Shaping the clay** can be done by various methods. Some of these methods involve *hand building,* in which potters use only their hands to shape the clay. The easiest hand-building method consists of pinching the clay into the desired form. Many beginners use this process to make small bowls called *pinch pots.* Another method of hand building, called *solid forming,* consists of shaping a sculpture out of a lump of clay.

The most common ways of shaping clay include (1) the coil method, (2) the slab method, (3) the mould method, and (4) the wheel method. The first two methods involve hand building, and the second two require equipment. A potter may use a combination of these methods. For example, the potter might form the body of a teapot on a potter's wheel and use a hand-building method to make the handle and spout.

***The coil method*** is one of the oldest and simplest ways of making pottery. After preparing the clay, the potter shapes part of it into a flat piece that will be the base of the ware. The remaining clay is rolled into long strips. Using the base piece as a foundation, the potter coils the strips of clay on top of one another.

The coils must be attached together to make the pottery strong. The potter attaches each coil layer to the next with a creamy substance called *slip.* Slip, which serves as a cement, is made by adding water to clay. Potters always smooth the inside surface of a piece of coil pottery. They may also smooth the outside surface, depending on the design of the piece.

***The slab method*** forms pottery from flat pieces of clay. The potter shapes the clay into flat slabs by pounding it with the fists or by flattening it with a rolling pin. Using one slab as the base, the potter places other slabs at right angles to it to form the sides of a piece of pottery. The slabs are then attached together with slip. Slabs may be difficult to work with, especially if they are large. For this reason, the potter may let the slabs harden slightly before fastening them together.

***The mould method*** is used to produce identical pieces of pottery. One technique of mould shaping, called *slip casting,* is used to turn out a large number of pieces of hollow pottery. In slip casting, the potter pours slip into a mould and lets part of it dry. The slip nearest the sides of the mould thickens quickly. After a few minutes, the slip in the middle of the mould is poured out, leaving the thicker slip attached to the sides. The thick slip dries into a finished piece of pottery.

Mould shaping can also be done by *jiggering.* Jiggering involves a device called a *jigger,* which consists of two pieces of plaster that form a mould. The potter puts the clay between the two pieces of plaster and, by pressing them together, squeezes the clay into the desired shape.

***The wheel method*** involves the use of a *potter's wheel.* This device consists of a round, flat, metal surface that turns while the potter shapes clay on it. Most wheels are electrically powered and turn when the potter presses a foot pedal.

As the wheel turns, the potter pushes the thumbs or other fingers into the centre of the spinning clay. This action forms the clay into a pot that has low, thick sides. The potter shapes the sides into the desired form by pressing one hand on the inside and one hand on the outside of the spinning pot.

**Decorating and glazing.** Potters can put simple decorations on their ware by pressing their fingers into the soft clay or by scratching lines into it. Elaborate designs can be drawn on pottery by using coloured substances that will not be damaged by heat during firing. Such substances include enamel, glaze, and slip.

One type of pottery decoration is called *sgraffito.* In this method, the potter puts a thin layer of the coloured substance on a piece of pottery of a different colour. The potter then uses a sharp tool to scratch through the coloured outer layer, allowing the colour of the clay body to form a design in the actual surface of the pottery beneath. Potters can make attractive decorations by filling in the sgraffito grooves with substances of various colours.

Glazing is used not only to decorate, but also to smoothen and waterproof pottery. Potters have developed many types and colours of glaze. They apply it in several ways, including brushing, pouring, or spraying it onto pottery. After a piece of pottery is glazed, the potter *fires* (bakes) it. Some types of pottery must be fired before being glazed. After glazing, they are fired again to bake the glaze. A few kinds of pottery are usually not glazed. They include a stoneware called *jasper* and an earthenware called *terracotta* (see **Terracotta**).

**Firing** makes pottery hard and strong. It also makes glaze stick to clay, and it hardens the glaze as well. Pottery is fired in an oven called a *kiln.*

## History

**Early pottery** consisted of simple household utensils. People in several parts of the world were making pottery by about 11,000 B.C. The Egyptians, about 3000 B.C., became the first people to glaze pottery. Pottery making spread from Egypt and the Near East to the areas around the Mediterranean Sea.

By about 1600 B.C., people on the island of Crete in Greece were producing beautiful pottery decorated with curved designs and pictures of animals. Cretan

### How pottery is made

First, the potter selects and prepares the clay. The potter shapes it, using one of several methods. Three common methods are described below. After the clay dries, the potter may coat it with a smooth glaze. Finally, the potter *fires* (bakes) the pottery in an oven to harden it.

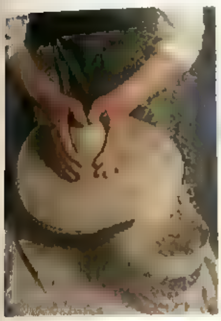
**The coil method** involves cutting out a bottom and then rolling ropes of clay and stacking them. The potter then may smooth the layers together.

**The slab method.** The potter first cuts the clay into slabs and then fastens the slabs to one another with a creamy clay called *slip.*

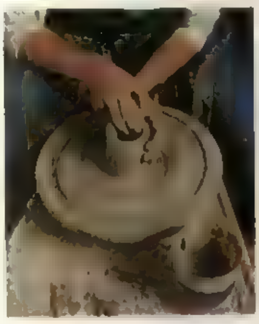
**The mould method.** Slip is poured into a mould. After the slip next to the mould hardens, the extra slip is poured out. The mould is split, and the piece is removed.

## Making pottery on a potter's wheel

Since early times, people have made vessels by using a potter's wheel. The wheel consists of a revolving disc mounted on a spindle. The potter spins the disc by using a foot control or mechanical power. Various hand and finger movements are used to mould the clay into the desired shape.



**A lump of clay** is spun on a wheel. The potter smooths it and pokes both thumbs into the top to make it hollow.



**The sides** of the vessel are shaped by drawing up the clay. The potter locks thumbs to steady the hands.

**Excess clay** is trimmed off with a tool, *above.* Then the potter removes the finished vessel with a wire or a knife.

**Finished pottery** is given colour, smoothness, and extra toughness by being glazed and fired in an oven.

methods of making and decorating pottery influenced Greek ware. The ancient Greeks made graceful pottery and decorated it with vivid designs.

Peoples in other parts of the world also developed pottery skills. In North and South America, many Indian tribes developed the art of making pottery. Tribes that created especially beautiful pottery included the Inca, the Maya, and the Pueblo.

In Africa, potters in the kingdom of Nok had developed an advanced pottery style by about 500 B.C. They specialized in making decorative pottery in the form of realistic human heads. Between about A.D. 600 and 950, artists in the African kingdoms of Ife and Benin used sculptured pottery figures as models for large, metal statues.

In China, potters had started to use the pottery wheel during the Shang dynasty (c. 1500-1027 B.C.). Chinese potters learned to make porcelain, probably during the Tang dynasty (A.D. 618-907). Potters of the Song dynasty (A.D. 960-1279) experimented with many pottery shapes and glazes. They created some of the loveliest pottery in history.

About 1200, the Chinese began to export pottery to the countries of the Near East. The potters of these nations combined Chinese styles with their own and developed new forms and designs. One of the new forms resulted in a type of colourfully glazed pottery called *majolica* (see **Majolica**).

**Pottery of the 1700's and 1800's** featured developments in Europe and the New World. The nations of the Near East began to export much of their pottery, including majolica, to Europe. European pottery-making centres, especially in Italy, copied the Near Eastern pottery. The European centres introduced new styles of their own as well, including types of majolica called *delft* and *faïence* (see **Delft; Faïence**).

In 1708, Johann Friedrich Böttger, a German chemist, became the first European to discover how to make porcelain. The Chinese had refused to share the secret of porcelain making. After European industrialists established factories to make porcelain, they also kept the method of porcelain making a secret. Many European wares greatly influenced pottery making. These wares included Meissen, Sèvres, Wedgwood, and Worcester.

English potters of the late 1700's were the first to industrialize pottery making. By the early 1800's, England led the world in pottery production, and it still exports more pottery than any other country. Some English potters still make pottery by traditional methods. These potters, usually called *studio potters* or *artist potters,* work on their own or in small groups. Their products include domestic objects, such as mugs and bowls.

**Modern styles of pottery** have developed during the 1900's. These styles resulted from the desire of potters to create individual, personal ware. Today, most studio potters use methods of shaping and decorating that were used before the Industrial Revolution of the 1700's and 1800's. Developments in pottery design that take place in one part of the world quickly reach and influence potters in other regions.

Since the early 1900's, people in many parts of the world have developed an interest in pottery making as a hobby. Amateur potters can go to specialized schools and pottery studios to learn the craft. Exhibitions encourage amateur and professional potters to show their wares and to exchange ideas.

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Medicine (picture: Florence Nightingale)
Ming dynasty (with picture)
Porcelain
Prehistoric people (Discoveries and inventions)
Pyrometry
Tang dynasty (picture)
Tile
Wedgwood ware

**Potto** is a small animal that lives in western Africa. It belongs to the order of animals that includes monkeys, apes, and human beings. But the potto looks more like a sloth than a monkey or ape. It is a member of a group of

**The potto** lives in the forests of western Africa. It usually sleeps during the day in hollow trees and hunts for food at night. The potto's big protruding eyes help it see easily in the dark.

animals called *slow lemurs* or *lorises.* The potto grows to between 35 and 50 centimetres long. It has a short tail, and the tips of several neck *vertebrae* (spine bones) project through the skin. The animal may use this partially exposed backbone as a defence. The potto is a slow-moving animal that spends its time in trees. It can grip branches firmly because its thumb faces the other fingers. The index finger is a mere stub and has no nails or joints.

Pottos live alone or in pairs, and are most active at night. They eat bats, young birds, insects, fruit, and eggs.

**Scientific classification.** Pottos belong to the loris family, Lorisidae, and make up the genus *Perodicticus.* The only species is *P. potto.*

**Pouched mammal.** See **Marsupial.**

**Poulenc, Francis** (1899-1963), was a French composer. He was particularly noted for his vocal music, which features beautiful melodies and great sensitivity to the words. Poulenc's songs and song cycles rank among his most important works.

Poulenc was a devout Roman Catholic. His *Mass in G* (1937) for chorus and *Gloria* (1959) for soprano, chorus, and orchestra reflect his deep religious feelings. He also wrote the religious opera *The Dialogues of the Carmelites* (1957) and a one-act tragedy for soprano, *The Human Voice* (1959). Poulenc was a fine pianist, and he developed a highly personal style of composing for piano in such works as *Trois mouvements perpétuels* (1918).

Poulenc was born in Paris. In the early 1920's, he became a member of a famous group of six French composers known as *Les Six.*

**Poulsen, Valdemar.** See **Tape recorder** (History).

**Poultry** are birds that are bred to provide meat and eggs for people. Chickens and turkeys are the most common kinds of poultry raised domestically. Other important kinds of poultry include ducks, geese, guinea fowl, pheasants, pigeons, and quail. Some kinds of poultry are particularly valued in certain countries. For example, guinea fowl and barbary ducks are important in France, and farmers in eastern Europe raise many geese. India produces many quail.

Although poultry are used primarily for food, they also provide several important by-products. Manufacturers use the feathers of ducks and geese to stuff pillows, duvets, and insulated clothing. Eggs are used not only as food, but also in making vaccines and other medicinal products. Most commercial chickens are *hybrids* specifically bred to be either egg layers or *broilers* (meat chickens).

Chickens, ducks, and turkeys are the most common kinds of poultry raised in Europe and North America. In areas such as Africa and India, egg production has always been an important village industry.

During the 1980's, the world's egg production increased by nearly one-third. Poultry meat production increased by more than 40 per cent and is still rising. In western Europe and the U.S.A., egg production has decreased slightly, owing to changes in eating habits. In Africa, eastern Europe, Latin America, the Middle East, and Asia, there has been a substantial increase in egg production. Japan and China are major egg-producing countries in Asia. Major poultry meat exporters are the U.S.A., Holland, France, and Brazil.

**Raising poultry.** Most poultry and eggs tend to be produced on specialist commercial farms that keep only poultry. Some farms, particularly those rearing broilers, have flocks of more than 100,000 birds. Some egg-production units can also be as large.

Hens start to lay eggs when they are about 20 weeks old. The birds may be kept in long, low buildings called *laying houses,* each of which may hold from 1,000 to 50,000 hens. In some of these houses, the hens live in cages that have a sloped floor so the eggs can roll out. In highly automated laying houses, mechanical devices carry feed and water to the hens, and a conveyor belt carries the eggs to a central collecting room. Droppings from the birds are conveyed out of such houses on manure belts, and are used as farm fertilizer. The hens are kept in the laying house for 12 to 15 months after they start to lay eggs. Then they are sold for slaughter and replaced by young birds. In Europe, there is a growing trend for farmers to return to traditional small units with birds kept out of doors on *free range.* In Switzerland, cages are banned and all chickens are free range. In the late 1980's, Holland and Sweden decided to phase out cage systems.

Most broilers are raised indoors on a dirt or concrete floor that is covered with *litter* (straw, sawdust, or some other material that absorbs moisture), keeping the birds clean.

Geese, turkeys and some other birds require more space because they are larger than chickens. Most of these birds are raised outdoors in pens, covered yards, or fenced fields. But some farmers raise turkeys indoors. Most ducks are raised indoors or in wire-sided units. Pheasants, quail, and other birds are raised in the same

way as broilers, but in smaller flocks. Quail can be kept in small cages.

Poultry feed is designed to promote rapid growth or high egg production. The main ingredient is maize, wheat, sorghum, or some other grain. The grain is mixed with protein supplements, such as soybean meal, fish, or meat by-products. Vitamins and minerals are also added. A broiler eats an average of 0.45 kilogram of feed per week and is killed when it is between 35 and 49 days old. Average carcase weight is 1.5 kilograms. A laying hen consumes about 1.8 kilograms of feed for every dozen eggs that she lays.

Diseases and parasites are a major problem of poultry farmers. Poultry farmers vaccinate their birds against disease, and certain drugs may be added to the drinking water or feed to control parasites. Respiratory ailments of poultry include *Newcastle disease, infectious bronchitis,* and *laryngotrachetis. Marek's disease* and *leucosis,* which kill many birds, result from tumours caused by viruses. Certain parasites cause a disease called *coccidiosis.*

**Marketing poultry and eggs.** Poultry raised for meat are marketed at various weights and ages in different countries. For example, broilers reach a market weight of 1.5 to 2.3 kilograms when they are about 40 to 49 days old. Turkey market weights vary widely. A typical hen turkey reaches its market weight of about 6.8 kilograms at 15 weeks old. Ducks are ready for market when they are 7 or 8 weeks old and weigh approximately 2.7 kilograms.

In industrial countries, poultry that have reached market weight are sent to processing plants to be slaughtered, inspected, and graded. They are then shipped to supermarkets and shops. In many countries, about 80 per cent of turkeys are sold frozen. In Europe, turkey meat, particularly in a processed form, is eaten throughout the year. In the United States, the greatest number of turkeys are sold for consumption at Thanksgiving and Christmas. About 40 per cent of all ducks and geese are sold frozen. In developing countries, poultry may be sold live in the open market and killed and prepared for the table in the home.

Egg farmers generally sell their eggs to packers or wholesalers, or directly to supermarkets and shops. Most eggs are sold to consumers fresh, though some are used in such processed food items as noodles and cake mixes. In many countries, eggs must be graded and packed in cartons or placed on trays for marketing. Egg washing is allowed in some countries, for example the U.S.A. and Australia, but is not allowed in the European Community. Inspectors determine the quality of the interior of an egg by *candling.* This technique involves examination of the egg while shining a strong light through it from behind. This enables cracked eggs or ones with internal blemishes to be removed.

During the 1970's, several new kinds of processed meat products from poultry were introduced. These meats included "frankfurters" made of chicken and "ham" made of smoked turkey.

A large poultry house holds thousands of chickens. Mechanical equipment brings feed and water to the birds automatically.

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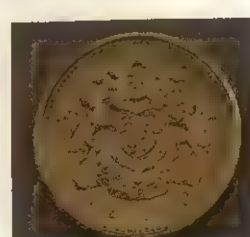
**Pound,** also called *pound sterling,* is the monetary unit of Great Britain and some other countries. The British pound (£) is equal to 100 new pence (*p*). There are paper notes for £5, £10, £20, and £50. Great Britain formerly issued notes of higher denominations up to £1,000. In 1983, the British government introduced a one-pound coin to replace the one-pound note, which it stopped issuing on Dec. 31, 1984.

Until 1931, Britain had made for circulation one-pound gold coins called *sovereigns.* Sovereigns were first made in 1489. Later, the sovereign was called a *unite,* in honour of the joining of England and Scotland under James I, who became king of both nations in 1603. George III chose the sovereign as the monetary unit, and it was first issued regularly in 1817. Half sovereigns, two-pound, and five-pound pieces were also coined. Sovereigns and other gold coins are now used for dealings with nations that require payment in gold.

When a nation buys more from other countries than it sells to them, it usually must pay the difference in an *international money* (widely accepted currency). The British pound has often been used as international money.



**A British one-pound coin** has a picture of Queen Elizabeth II on the front and a symbol of a part of Great Britain on the back.

But gold and United States dollars are the major forms of international money.

See also **Money** (table: Exchange rates).

**Pound** is a common unit of weight in the British system of weights and measures used before the adoption of the metric system, and is the customary system used in the United States and several other English-speaking countries.

There are three kinds of pounds—*apothecaries', avoirdupois,* and *troy.* The pound avoirdupois has 16 ounces. This is equal to 0.4535924 kilogram. Troy and apothecaries' pounds have 12 ounces, and have 0.3732417 kilogram each. The troy pound is used for weighing precious metals. The avoirdupois pound is used for weighing such merchandise as meat, cheese, and butter. Pharmacists sometimes use the apothecaries' pound in preparing medicines. Most pharmacists use the metric system. Pound is abbreviated as *lb.* See also **Apothecaries' weight; Avoirdupois; Troy weight.**

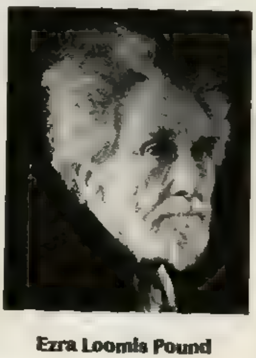
**Pound, Ezra Loomis** (1885-1972), was an American poet and critic. He became one of the most influential and controversial literary figures of his time. Pound's admirers regard his *Cantos* as the most important long poem in modern literature. His detractors find the *Cantos* confused and filled with malice.

Pound left the United States, which he called "a half-savage country," in 1908 to live in Venice and London. He published his first poetry in Europe, and he became a friend and critic of writers William Butler Yeats and James Joyce. He also helped such then unknown writers as T. S. Eliot and Robert Frost.

Pound's early work, collected in *Personae* (1909), reflects his deep conviction that the poet plays a vital role in maintaining the standards of society. In 1920, Pound published *Hugh Selwyn Mauberley,* a despairing poem describing his struggles in what he considered a morally decaying culture. Pound then began examining what he felt had gone wrong with the world.

In the first of his *Cantos,* written from about 1915 to 1925, Pound tries to "tell the tale of the tribe" in a highly personal manner. He traces the rise and fall of Eastern and Western empires, emphasizing the destructive role of materialism and greed. The *Cantos* written during the late 1920's and early 1930's deal with the corruption Pound saw developing in American life since the time of two of his heroes, Thomas Jefferson and Martin Van Buren. Pound's indignation finally turned to anti-Semitism and opposition to capitalism.

Pound became an admirer of the Fascist rule of Italian dictator Benito Mussolini. During World War II (1939-1945), Pound broadcast Fascist propaganda to the United States. After the war, the United States arrested him for treason. He was judged insane in 1946 and spent 12 years in a Washington, D.C., mental hospital. He was released in 1958 and returned to Italy.



Ezra Loomis Pound

Pound was born in Hailey, Idaho, U.S.A., and attended Hamilton College, New York, and the University of Pennsylvania. He taught briefly before moving to Europe.

**Pound sterling.** See **Pound** (money).

**Poussin, Nicolas** (1594-1665), was the most highly respected French painter of his age. Poussin believed that painting should appeal to the mind more than to the senses. His works are meant to be read from figure to figure and incident to incident, and to be brought together as a whole in the viewer's mind. He believed an artist should choose as subjects only the noblest human actions, and he took almost all his subjects from mythology and from the Bible.

Like many painters of the mid-1600's, Poussin believed that drawing was a more important foundation of painting than colour. The clarity of Poussin's forms reflects this belief. However, for all of Poussin's sober forms and clarity of colour, his paintings, especially his religious works, show deeply felt emotion.

Poussin was born in or near Les Andelys, near Rouen, France. He went to Paris at the age of 18 to become a painter, but he did not develop his own style and gain success until he travelled to Italy 12 years later. He lived in Rome nearly all of the rest of his life. Poussin's paintings were in great demand during and after his lifetime. Like all good artists of his time, he was supported by aristocratic patrons, and he held the position of First Painter to the king of France.

For examples of Poussin's work, see **Painting** (Nicolas Poussin) and **Mythology** (How myths began). See also **Classicism** (The qualities of classicism).

**Poverty** is the state or fact of being in want. People are poor if they lack enough income and resources to live adequately by the accepted living standards of their community.

Standards may vary greatly according to time and place. Many people who live in Western industrialized societies, for example, believe they must have a car to live well. They would consider themselves poor if they could not afford to buy one. Yet many people who live in other countries regard cars as luxuries. They would not consider the lack of a car a sign of poverty. People who lived in industrialized nations when the motor car was first introduced did not at that time consider cars necessary for a decent standard of living.

### Effects of poverty

Poverty causes suffering among millions of people. People who live in poverty are less likely to eat the foods they need to stay healthy or to receive good medical care when they are ill. Their children may not have enough to eat. The very poor have more diseases and die at younger ages than other people do.

Many low-income families live in city slums or rural areas that do not provide the basic needs of food, shelter, and clothing. The only work available may offer low, uncertain income and little security. Many poor people work in dangerous or unhealthy conditions.

Poverty brings despair, anger, or lack of interest in anything except one's own worries. Financial, emotional, and medical problems strain family ties.

The poor have little influence in the community. Businesses are interested more in people who buy their goods and services. The poor have limited political

power. Many of the poor believe that no political candidate can help them and do not vote in elections.

Studies show that large numbers of children born into low-income families remain poor all their lives. Many come to feel as helpless as their parents. In some parts of the world, poor people value large families as a source of family security—to help work the land or to take care of elderly parents.

Underprivileged children may suffer from lack of nourishment for healthy growth during their important early years. They can seldom expect to attend good schools that will educate them for a full life.

### Measuring poverty

At least a billion people, or a fifth of the world's population, were so poor in the late 1980's that their health and lives were in danger. Definitions of poverty vary greatly from country to country, just as living standards do, and it is difficult to give precise figures. What is sure is that the most widespread and severe poverty occurs in nations with few or undeveloped resources. These nations are usually called the *developing nations,* or the *Third World* (see **Third World**).

More than 100 countries come into the category of *developing nations.* They are former colonies of industrial nations, and one of the causes of their present poverty is their colonial past, when the powers that colonized them deprived them of much of their wealth. A few developing nations made political alliances with Eastern bloc countries or with Western democracies during the years of the Cold War between East and West (see **Cold War**). According to the World Bank, annual income *per capita* (per person) in the 1980's was less than 425 United States dollars (U.S. $425) in 39 developing countries. Thirty-five developing countries stood between U.S. $426 and U.S. $1,600, and 19 between U.S. $1,601 and U.S. $7,500.

About 25 per cent of the people in Asia lived in *absolute poverty* in the 1980's. People living in absolute poverty are defined as those with an annual income between U.S. $50 and U.S. $500, by the Worldwatch Institute, a group that studies poverty. In North Africa and in the Middle East, 28 per cent of the people lived in absolute poverty. In sub-Saharan Africa, 35 per cent were in that class. About two-thirds of the severely poor were children under the age of 15.

The world's two most populous countries, China and India, made progress in reducing poverty in the 1980's. But there were increases in poverty in Latin America and Africa. Most of the world's very poor live in rural areas, but in Latin America about half live in cities. Average incomes in countries in Africa and Latin America dropped by between 10 and 25 per cent during the 1980's.

**Poverty line.** The United States sets an official *poverty line* each year. This is an income level below which people are considered to be poor. In 1988, the poverty line was U.S. $12,000 for a family of four. The measurement is based on the amount of money households need to live adequately. It assumes that a family should not have to spend more than a third of its income on food. Countries where household budgets for food exceed one-third of income include India (55 per cent), Philippines (54 per cent), South Africa (39 per cent), and Ireland (37 per cent).

Comparisons among countries may be misleading because of great variations in local economic conditions and in standards and customs. The United States ranks high in *per capita* income (U.S. $16,400), but about 32,000,000 people were living below its poverty line in 1988.

**Other measurements.** The share of national income distributed between the wealthier and poorer households varies widely throughout the world. In Japan, for example, 37 per cent of the country's income went to the 20 per cent of households that were richest and 9 per cent of its national income went to the 20 per cent of households that were poorest. In India, half went to the top 20 per cent of rich households and only 5 per cent to the bottom 20 per cent of poor households. In the United States, the figures were 46 per cent to the richest and 4 per cent to the poorest households. In the Philippines, 53 per cent went to the richest families, and 5 per cent to the poorest.

Another measure is the proportion of households in rural areas who own no land. This proportion is about 40 per cent in Africa, 50 per cent in Malaysia and India, 70 per cent in the Philippines, and 75 per cent in the Latin American countries of Peru and Ecuador.

**The homeless.** The number of people in the world having nowhere to live totalled an estimated 100 million at the end of the 1980's. Homelessness is an obvious sign of poverty. The United Kingdom has laws forcing local government to provide housing for those who need it. Long waiting lists for public housing, however, have led to authorities placing many families in temporary accommodation for long periods. In the developing nations, cities such as Bombay, India, have long been known for the huge number of homeless, especially homeless children, who roam their streets.

### Causes of poverty

Debt is a major cause of individual poverty, often made worse by the loss of a job or means of livelihood. In a country such as India, *debt bondage* keeps very many families in poverty. The debt can often never be repaid. The debtor must work for the creditor and almost becomes the creditor's slave. Debt bondage may continue in a family for generations, with sons inheriting the debt from their fathers.

When a large part of a community suffers economic reverses, war, crop failure, or epidemic disease, poverty can affect whole classes and communities. Any minority or group singled out for discrimination is usually unable to take advantage of educational or employment opportunities open to others because of prejudice. The source of the prejudice may be any of several factors, including racial or national origins, religion, language, or sex. See **Civil rights; Segregation, Racial; Women's Movement.**

Natural disasters cause widespread poverty. Ireland's potato famine in the mid-1840's led to the death of hundreds of thousands. Many left the country to escape starvation. During the 1980's, drought and war killed hundreds of thousands in Africa, and, in 1991, a cyclone devastated the island communities of Bangladesh bringing death to hundreds of thousands more. All these disasters plunged millions of survivors into want.

Economic panics and depressions can also cause distress far beyond an individual's personal control.

### The fight against poverty

Many governments and aid agencies are fighting against poverty, both in developing nations and among disadvantaged people in the developed industrialized democracies of the West. Good welfare and social services, job training programmes, and the passing of laws against discrimination are ways in which some developed countries have tried to minimize the effects of poverty in their own lands. In the developing countries, however, serious poverty exists on a national scale, and other methods must be employed.

Charitable organizations and international aid agencies operate in many developing countries. They distribute food and medicines to areas of the greatest need, often in the face of great local difficulties over poor transport routes or natural barriers such as mountains. A major obstruction to aid distribution is war.

Some organizations seek to help the inhabitants of developing countries improve their technology or use what they have more efficiently. These and other large and small programmes give hope for a future in which poverty may be much reduced. Offering small loans to poor villagers in India with realistic repayment conditions has proved successful. Tree-planting programmes and adult literacy programmes also help.

Experts have proposed many measures to eliminate poverty on a national level among the developing countries. These include reducing or cancelling the debts owed by developing countries to Western industrial nations, and removing import barriers so they can sell their products to the developed world more easily. The World Bank, the United Nations, and many other agencies sponsor programmes for economic growth in developing nations. Many observers believe that such growth should be planned so that it places minimal burdens on a country's natural resources, such as forests.

### History

From ancient times, people from many different societies considered poverty to be an inescapable fact of life. Most communities regarded it as a curse. Some religions, such as Buddhism, Judaism, Christianity, and Islam, included *almsgiving* (charitable donations to the poor) as an essential part of their code of life. Many saints and holy men lived a life of poverty. In India, the inflexibility of the caste system ensured that those on the lowest social level had no hope of escaping poverty.

The economy of many nations once depended on slavery. In some societies, slaves had a chance to earn money and eventually buy their freedom. But most suffered the twin hardships of enslavement and poverty.

As societies changed from a largely agricultural to an industrial way of life, many rural labourers drifted from the land to live in towns, and fell into a new poverty trap, urban unemployment. Under medieval feudalism, each lord of the manor was responsible for relief of the needy in his own area. With the end of the feudal way of life, that responsibility passed to the local community. The church or local government usually provided relief. In Britain, a system of "poor law" eventually grew up. Homeless families lived off the parish through the payment of outdoor relief. In the 1800's, the system was changed so that the homeless were forced to live in workhouses. Those who would not received no relief.

The Industrial Revolution in Europe and America attracted huge numbers of people into the towns and cities. Most factory workers in the new industries received low wages. Many factories employed children. Urban unemployment rose. Town populations expanded and many poor people lived in wretched slums.

As the 1800's ended, many people at last began to realize that poverty was not inevitable and sought reforms. The British writer Arnold Toynbee caught public attention with his book *The Industrial Revolution,* published in 1884, a year after his death. The Toynbee Settlement House, the first welfare centre to operate in a slum area of London, opened soon afterward to serve the city's poor and was named in his honour. Another influential reformer was Jane Addams. She established Hull House, a welfare centre in Chicago, in the United States, in 1889 and successfully pressed for laws to protect the neediest section of American society.

Germany passed the first old-age insurance programme by 1889, and by the early 1900's many other European countries had similar laws. In 1930, the U.S. government set up the first comprehensive federal programme to provide needy people with social security.

The 1960's U.S. civil rights movement focused attention on poverty among ethnic minorities. During the 1970's and 1980's, various advances were made in the fight against poverty. But economic recessions in 1981 and 1991 hampered progress.

**Powder.** See **Cosmetics**; **Gunpowder**.

**Powder horn** was an instrument for carrying the gunpowder used in muzzle-loading muskets. It was usually made from the horn of an ox or cow. The hollow horn was cut at the ends. Caps, usually metal, were placed on the ends of the horn to hold the powder in. To load a musket, the cap on the small end of the powder horn was removed, and the powder poured into the muzzle of the gun. Powder horns were usually slung over the wearer's shoulder.

**Powder metallurgy** is a process that reduces metals to powdered form and presses the powder into certain somewhat restricted shapes. A heating process called *sintering* is used to bind the metal powders and add strength to the finished product (see **Sintering**).

Powder metallurgy has many advantages over other methods of making metal objects. Some metals will not mix (alloy) when heated to the *fusion* (melting) point. But these metals can be made to form valuable compounds by powdering them and then mixing the powders together. For example, graphite will not fuse with metals by heat alone. But it can be powdered and mixed with powdered metals, pressed into shape, and heated to make a bearing. Such a bearing does not need frequent oiling because the graphite acts as a self-lubricant. Other advantages of powder metallurgy include rapid production, high dimensional accuracy, controlled *porosity* (number, shape, and size of pores), low scrap loss, and use of unskilled labour.

Metals are made into powders in many ways. Molten metals can be *atomized* (broken down into tiny drops), and some solid metals can be crushed. Another method is electrolysis (see **Electrolysis**). A fourth way is to heat the oxide compound of the metal in contact with hydrogen.

**Powell, Anthony** (1905- ), an English writer, is best known for his 12-volume series of novels called *A Dance to the Music of Time.* In the series, Powell describes what he considers the changing nature of the English upper-middle class from the early 1920's to the 1970's. The novels are narrated by Nicholas Jenkins, who speaks for the author. Jenkins records his own experiences and those of a group of characters, especially Widmerpool, a ruthless, aggressive, self-made man. The series began with *A Question of Upbringing* (1951) and concluded with *Hearing Secret Harmonies* (1975).

Powell was born in London. He began his literary career with the comic satiric novels *Afternoon Men* (1931), *Venusberg* (1932), *From a View to a Death* (1933), and *Agents and Patients* (1936). Powell also wrote *John Aubrey and His Friends* (1948), a biography of English author John Aubrey. His plays include *The Garden God* (1971) and *The Rest I'll Whistle* (1971). Powell wrote four volumes of autobiography (1976-1982) under the title *To Keep the Ball Rolling.*

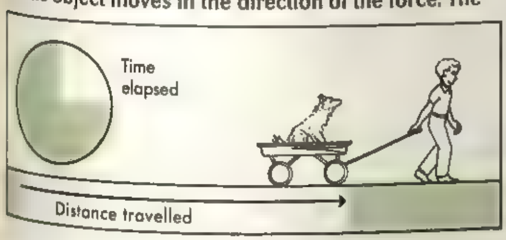
**Powell, Cecil Frank.** See **Nobel Prizes** (table: Nobel Prizes for physics—1950).

**Power,** in arithmetic, is the product of a number multiplied by itself a specified number of times. For example, $3\times3\times3\times3\times3$ is called the fifth power of 3, and is written $3^5$. In $3^5$, the number 3 is called the *base* and 5 is called the *exponent.* The second and third powers of a number are called its *square* and its *cube* (see **Cube; Square**). The first power of a number is the number itself and the zero power of a number is one. For example, $3^1$ is 3 and $3^0$ is 1. The concept of power also applies to negative numbers and fractions. For example,

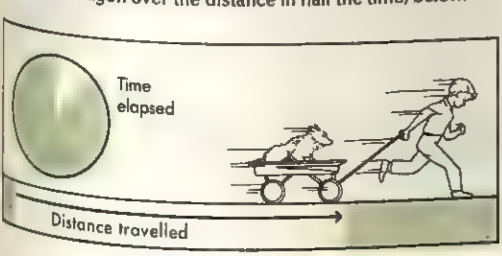
$$3^{-2} \text{ is } \frac{1}{3^2} \text{ and } 3^{\frac{1}{3}} \text{ is } \sqrt[3]{3}.$$

See also **Googol; Logarithms.**

**Power,** in physics, is the rate of doing work. Physicists consider that work is done whenever a force moves an object against a resistance. The amount of work done depends on the size of the force and on the distance that the object moves in the direction of the force. The idea of power involves time, as well as force and distance. The power exerted determines the amount of work that can be accomplished per unit of time.




**The power needed to pull a wagon** depends on its weight, and how far and how fast it is pulled. A boy uses a certain amount of power to pull a dog in a wagon over a given distance in a set time, *above.* He must use twice as much power to pull the dog and wagon over the distance in half the time, *below.*




A task requires the same amount of work whether done quickly or slowly. But greater power is necessary to do the work quickly. For example, a horse does the same amount of work if it pulls a load over a given distance in 20 seconds or in 10 seconds. But it uses twice as much power to perform the task in the shorter time.

Power can be calculated with the following formula:

$$P = \frac{W}{t}$$

In the formula, $P$ stands for power, $W$ for work, and $t$ for time. Physicists measure work by multiplying the force times the distance. Therefore, the formula for power can also be written:

$$P = \frac{Fd}{t}$$

Here $F$ stands for force and $d$ for distance.

In systems of measurement, power is always expressed as units of work divided by units of time.

In the metric system, the common unit of power is the *watt.* One watt is the power needed to perform one *joule* of work per second. One joule of work is done when 1 *newton* of force moves an object 1 metre (see **Newton**). For example, let us consider the work done if a 10-kilogram object is lifted 5 metres. The force acting on the 10-kilogram object is its mass (10 kilograms) multiplied by the acceleration due to gravity, $g$, which is 9.8 metres per second per second. The force is therefore 10 kilograms $\times$ 9.8 metres per second per second $=$ 98 newtons. The work done is equal to the force (98 newtons) multiplied by the distance over which the force is applied (5 metres). The work done is therefore 98 newtons $\times$ 5 metres $=$ 490 joules. If the work is performed in 4 seconds, the power used, $P$, is 122.5 watts:

$$P = \frac{490 \text{ joules}}{4 \text{ seconds}} = \frac{122.5 \text{ joules}}{1 \text{ second}} = 122.5 \text{ watts}$$

The basic unit of power in the customary, or English, system is *foot-pounds per second.* One foot-pound of work is done when a force of 1 pound moves an object 1 foot. Another unit of power in the customary system, the *horsepower,* equals 550 foot-pounds of work per second. The horsepower originally represented the amount of power delivered by a typical draft horse. One horsepower equals 746 watts.

**Related articles** in *World Book* include:

| | | |
|---|---|---|
| Energy | Horsepower | Watt |
| Foot-pound | Joule | Work |
| Force | | |

**Power,** in the social sciences, is the ability of persons or groups to impose their will on others. Persons with power can enforce their decisions by applying, or threatening to apply, penalties against those who disobey their orders or demands. Power is present in almost all human relationships. Teachers have power over students, employers over employees, parents over children, bullies over weaklings, and militarily strong nations over weak nations.

**Forms of power** include *coercion, influence,* and *authority.* Coercion is the use of physical force to enforce decisions. Influence is the ability to produce an effect through example, persuasion, or some other means without using force.

Authority is power that is based on agreement by a majority of the members of a society or group. For example, teachers have power (authority) over their students because it is widely recognized and agreed that they must have it to keep order and teach effectively. In democracies, the authority of government is based on the consent of the governed. Leaders chosen by the voters in free elections have authority to make decisions for the people.

**Main sources of power** include (1) superior resources, (2) superior numbers, and (3) superior organization.

Resources may be physical or human. Physical resources include money, goods, and property. They give a person the power to buy what he wants, and enable him to command the services of others. Human resources that give power include intelligence, knowledge, skill, prestige, social position, bravery, and personal charm or beauty. Such qualities become a source of power when they enable a person to lead, influence, or control other people.

Power in numbers can be seen in elections which give the winners the authority to make decisions for the group. But numbers are not all-important. Inferior numbers can exercise power when they have control of important resources, such as the military.

Superior numbers and resources do not by themselves give a person a high degree of power over others. People must know how to use their resources effectively. They do this through organization. Individuals alone have relatively little power to affect important decisions. But by joining together in some kind of organization, they can become powerful. Political parties, pressure groups, and other associations attempt to gain power through social organization. Countries also join together to consolidate power. International power groups include the European Community (EC) and the Organization of American States (OAS).

**Systems of power.** Power relationships occur in all societies and organized groups. There are important differences in how private and public power systems enforce their decisions. The leaders of private groups—such as businesses and clubs—can fine, suspend, and even expel dissenting members. But only public power systems—that is, governments—can legally use physical force, including imprisonment. Governments control the police and the military, the chief agents of force. This monopoly of force makes control of the state an important source of power.

The social organization that enables certain people to govern in all the organized groups of a community or society makes up the *power structure*. Sometimes, the most powerful people are referred to as *the Establishment*, or the *power elite*.

See also **Government**.

**Power, Harry** (1819-1891?), was an Australian bushranger. He was born Henry Power in Waterford, Ireland. In 1840, he was transported to Van Diemen's Land (now Tasmania) for robbing a bank. He ran away long before his seven-year sentence had expired and crossed to Victoria, on mainland Australia. In 1855, Power was sentenced to 14 years for wounding with intent after an argument with troopers. Weeks before his sentence was due to expire in 1869, he escaped from Pentridge. He began bushranging in northeastern Victoria, probably because he knew the Lloyd family there. The Lloyds were relatives of the Kelly family.

Power's bushranging career showed some flair, and he was known as a colourful but harmless rogue. He kept highway robbery appointments made in advance. In 1870, he robbed Robert McBean, a squatter, justice of the peace, and close friend of the chief commissioner of police. McBean's complaints led to the offering of a reward for Power and a stepped-up police hunt for the bushranger. In 1870, after being betrayed by one of the Lloyds, Power was sentenced to 15 years and 6 months in prison. He was released in 1885, but his last years remain shrouded in mystery. In bushranging history, however, Power is remembered for one significant action. While he was at large, he took on a young "apprentice." That apprentice's name was Ned Kelly. See **Kelly, Ned.**

**Power failure.** See **Electric power** (Providing reliable service).

**Power House Museum** in Sydney, Australia, displays items of science and technology from Australia's past. Its exhibits range from a glass dog only a centimetre high to a 63-metric ton steam locomotive and a Catalina flying boat with a wingspan of 32 metres. The museum is housed in the former Ultimo Power Station, which was built in 1889. The building was converted to a museum in the 1980's at a cost of more than 35 million Australian dollars.

**Power of attorney** is a legal, written document, usually in the form of a deed. The signer of the document appoints an agent or attorney who has the power to act for the signer.

The power of attorney is especially useful to people who are ill and unable to conduct their own affairs, or to people who must be away from home for a long time. In times of war, many members of the armed forces make out a power of attorney to someone at home. This is especially true of those who leave civilian business to the management of friends and relatives.

A *general* power of attorney permits the agent to act for the signer in all circumstances. A *special* power of attorney permits the agent to do only those things that the signer lists in the document. Once those things are done, the power lapses. The death of the signer usually voids a general power of attorney.

**Power plant** is any system that generates power. Power plants include the various types of engines in aeroplanes, cars, locomotives, and other vehicles. Most of them use petrol or oil for fuel. Larger power plants, often called *power stations*, use coal, nuclear fuel, or oil to produce electricity.

**Related articles** in *World Book* include:

| | | |
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| Aeroplane (Power for flight) | Hydraulic engine | Rocket |
| Car (The engine) | Jet propulsion | Solar energy |
| Diesel engine | Locomotive | Steam engine |
| Electric power | Nuclear energy | Turbine |
| Horsepower | Nuclear reactor | Water power |
| | Petrol engine | |

**Power station.** See **Power plant.**

**Powerlifting.** See **Weight lifting.**

**Powers, Hiram** (1805-1873), was one of the best-known American sculptors of the mid-1800's. His *Greek Slave* (1843), a full-length female nude, ranks among the most famous sculptures in American art. Praised as a

symbol of beauty, virtue, and innocence, the marble statue helped establish the nude as an acceptable subject for art in the United States.

Powers was especially gifted at creating realistic portrait busts of famous people, including *Andrew Jackson* (1835) and *Henry Wadsworth Longfellow* (1869). His other works include *Fisher Boy* (1844), *California* (1858), *Benjamin Franklin* (1862), and *Thomas Jefferson* (1863). He was born in Woodstock, Vermont, U.S.A.

**Powys** is the family name of three brothers, all of whom achieved fame as writers.

**John Cowper Powys** (1872-1963) was a British novelist, essayist, and poet. His novels include *A Glastonbury Romance* (1932) and *Owen Glendower* (1940). He wrote essays on philosophy and literature. His collections of verse include *Mandragora* (1917) and *Samphire* (1922). He was born in Shirley, in Derbyshire, England.

**Theodore Francis Powys** (1875-1953), usually called T. F. Powys, was a British novelist and short-story writer. His best-known novels include *Mr. Weston's Good Wine* (1927) and *Unclay* (1931). His books of short stories include *The Left Leg* (1923) and *Fables* (1929). He was born in Shirley, in Derbyshire, England.

**Llewelyn Powys** (1884-1939) was a British essayist and novelist. His books include *Ebony and Ivory* (1922), *Skin for Skin* (1925), *Apples Be Ripe* (1930), and *The Pathetic Fallacy* (1930). He was born in Dorchester, in Dorset, England.

**Powys** was a county in mid-Wales. It ceased to exist as a local government area in April 1996. Much of the region is mountainous moorland. Many mountain valleys of Powys have been dammed to make reservoirs. Most of the people depend for their living on agriculture or tourism. For many years, limited employment caused many young people to leave Powys. But after the 1950's, job opportunities began to improve as new industries moved to the region.

The county of Powys was created in 1974, when the local government of Wales was reorganized. It took in the old counties of Montgomeryshire and Radnorshire, and most of the old county of Breconshire. The name Powys was originally the title of a *principality* (area governed by a prince) in North Wales during the Middle Ages.

### People and government

Welsh is the everyday language of people in the northwestern and southwestern parts of Powys. In these districts, many primary schools use Welsh as the language of instruction. None of the secondary schools in Powys is entirely Welsh speaking. But the language is taught in all secondary schools.

**Customs and recreation.** Powys strongly retains the Welsh tradition of the *eisteddfod,* a competitive meeting for such activities as singing and dancing. Many popular pastimes are connected with agriculture, in-

**The Brecon Beacons** are now part of a national park that lies in southern Powys, Wales. The park has many scenic attractions, such as this waterfall near Bwlch.

**Facts in brief about Powys**

**Largest towns:** Newtown, Ystradgynlais, Brecon, Welshpool, Llandrindod Wells.
**Area:** 5,075 km².
**Population:** *1991 census* 116,500.
**Chief products:** *Agriculture*—beef and dairy cattle, sheep. *Manufacturing*—clothing, electrical goods, light engineering goods, shoes, textiles.

cluding agricultural shows. The largest is the Royal Welsh Agricultural Show, held every July at Builth Wells.

**Local government.** The former county of Powys was divided into three local government districts: *Brecknock, Montgomeryshire,* and *Radnor.* In April 1996, the county and districts were abolished, and the unitary authority of Powys was set up. The new unitary authority has all local government powers within its area. Montgomeryshire is designated as the area for a mid-Wales *new town,* which was named as a special, rapidly growing town in 1976 (see **New town**). The county is policed by the Dyfed-Powys Constabulary. The crown court meets in Welshpool.

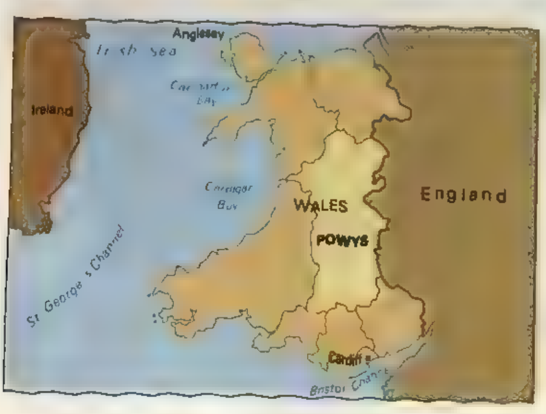
## Economy

**Agriculture** is the most important economic activity in Powys. But the number of people working in agriculture has decreased sharply since the 1940's.

In the upland areas that cover most of Powys, farmers raise sheep and beef cattle. In the lower river valleys, soil and climate are better than in the uplands. Farmers in the lowland areas grow crops and rear dairy cattle. The main agricultural market town in Powys is Welshpool.

Forestry is an important industry in Powys. Both the Forestry Commission and private landowners have planted large areas of trees. Most of the forests are located in western and southern Powys.

**Mining and quarrying.** Some coal is mined in the southwestern corner of Powys, near Ystradgynlais. Quarrying of granite and limestone is flourishing in several parts of the county. Lead mining at Pumlumon, an important industry during the 1800's, is now carried out only on a small scale.




**Powys** occupies about a quarter of the area of Wales. Most of its eastern edge is on the border with England.

**Manufacturing** industry has developed in Powys only since the late 1950's. Several towns now have small factories. Local products include clothing, clocks and watches, light-engineering goods, and shoes.

**Tourism.** Tourists are increasingly providing income for the people of Powys, particularly by taking accommodation in farmhouses.

Within Powys lies one of Wales's greatest tourist attractions, the Brecon Beacons National Park. Its sights include Llangorse Lake and Taf Fechan Reservoir, one of many in Powys (see the section on *Rivers and lakes,* below). Pony-trekking and hillwalking are popular tourist activities in Powys.

**Transportation and communication.** The car is the main form of transport in Powys, and most families have cars. Powys has limited public transport facilities. Only two railway lines cross the region. The Cambrian Coast railway passes through Newtown and Welshpool. The Central Wales railway, linking Shrewsbury with Swansea, passes through Llandrindod Wells.

The main local newspaper is the *County Times,* published weekly in Welshpool. Two weekly newspapers published in Brecon are the *Brecon and Radnor Express* and the *Radnor Express.*

## Land

**Location and size.** Powys borders on all but one of the former Welsh counties. In the north, it borders on Clwyd and Gwynedd; in the west, on Dyfed; and, in the south, on West Glamorgan, Mid-Glamorgan, and Gwent. In the east, Powys borders on the English counties of Hereford and Worcester, and Shropshire.

Powys measures about 122 kilometres from north to south and averages about 45 kilometres from east to west. The region occupies about a quarter of the area of Wales.

**Land features.** Much of the land in Powys is mountainous moorland, especially along the northern, western, and southern borders of the region. The highest peak in Powys is Pen-y-Fan, one of the Brecon Beacons in the south of the county. It reaches 886 metres. The Brecon Beacons contains many extensive limestone caves. Eastern Powys is an area made up mainly of plateau and lowland.

**Rivers and lakes.** Two great rivers, the Severn and the Wye, rise only about 3 kilometres apart in the Pumlumon mountain range. The Severn rises in Powys and the Wye in Dyfed. The Severn and Wye, and their tributaries, flow eastward across the region and into England. The River Usk, in southern Powys, also flows eastward past the Brecon Beacons.

In some of the mountain areas of Powys, there are spectacular waterfalls. The most famous is Pistyll Rhaeadr. It is located in the extreme north. Another beautiful waterfall is Sgwd Henryd, in southern Powys. Most of the large lakes in Powys are artificially created reservoirs.

**Climate** varies considerably within Powys. In the highland of western Powys, annual rainfall is about 180 centimetres. The eastern valleys have only half as much—about 90 centimetres of rain each year. The average temperature for the region as a whole is about 5 °C in February, the coldest month. In August, the warmest month, the average is about 14 °C.

### History

Bronze Age remains include single-standing stones, stone circles and round barrows. The county also has the remains of several Iron Age forts. The Romans built roads up the valleys of the rivers Severn, Usk, and Wye, leading to frontier forts at Brecon, Caersws, Clyro, and Forden. The largest Roman fort in the area was at Brecon.

After the Romans left Britain, Powys continued to be a frontier area. Offa, king of Mercia in the A.D. 700's, set up a physical boundary to mark off his kingdom from Wales. The boundary, called Offa's Dyke, can still be followed for much of its length in eastern Powys.

Norman invaders from England caused much fighting in Powys. In 1282, Llewelyn ap Gruffydd, who had freed most of Wales from Norman rule, was defeated and killed at Cefn-y-Bedd, near Builth Wells. A hundred years later, another Welsh rebel, Owen Glendower (in Welsh *Owain Glyn Dŵr*), was active in Powys during the reign of Henry IV. He called a parliament at Machynlleth.

In 1536, England and Wales were united under one government. At that time, the three shires of Brecon, Radnor, and Montgomery were created. During the Civil War, in the mid-1600's, a large battle was fought at Montgomery, and Montgomery Castle was destroyed.

In the 1830's and 1840's, the Powys area had much civil unrest, including Chartist riots at Llanidloes and Rebecca riots in various places.

Famous people associated with Powys include the painter Richard Wilson, who was born at Penegoes. Sarah Siddons, born in Brecon, was a great Shakespearean actress. The social reformer Robert Owen was born at Newtown. In Llanwnog churchyard is the grave of the famous Welsh lyric poet Ceiriog (see **Welsh literature** [Later literature]).

**Related articles** in *World Book* include:

| | | |
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| Archaeology | Rebecca riots | Wales |
| Chartism | Siddons, Sarah Kemble | Wilson, Richard |
| Glendower, Owen | | |
| Offa's Dyke | | |

**Poynting, John Henry** (1852-1914), was a British physicist whose most important research was on the theory of electromagnetism. He described mathematically the direction in which a quantity of electrical energy may move. It is known as the *Poynting vector.* He also measured the density of the earth and the pressure of light on such bodies as a comet's tail. Along with physicist J. J. Thomson, he wrote *Textbook of Physics.* Poynting was born at Monton, near Manchester, England.

**Poznań** (pop. 575,100) is a city that lies on the Warta River in west-central Poland. For location, see **Poland** (political map). Products of Poznań include machinery, metals, and transportation equipment. The city has two universities and many historic buildings. Poznań was probably founded in about A.D. 800. In June, 1956, antigovernment riots in Poznań and other Polish cities resulted in reforms that gave the people increased economic, educational, and religious freedom.

**PR.** See **Public relations.**

**Prado.** See **Madrid** (Education and cultural life).

**Prado y Ugarteche, Manuel.** See **Peru** (The rise of APRA).

**Praetor** was a law official in ancient Rome. Citizens brought complaints before the praetor. The praetor decided which complaints were justified, and assigned them to judges for trial. When taking office, a praetor issued an *edict* (public order) stating how the law would be interpreted in granting trials. Each new praetor generally copied or improved upon the successful edicts of earlier praetors. In that way, praetors helped build the Roman legal system, which in turn influenced many of the legal systems used today. Praetors also served as governors of Roman provinces, and later they presided over criminal courts.

The office of praetor was created in 367 B.C. The number of praetors was increased to two in 242 B.C., and eventually increased to 16.

See also **Law** (Ancient Roman law).

**Praetorian Guard** was the personal guard of the Roman emperors. Until the reign of Septimius Severus (A.D. 193-211), only soldiers recruited in Italy could serve in the guard. Septimius opened the guard to soldiers from all the Roman legions throughout the empire.

Emperor Augustus made the praetorians a standing army. He divided them into nine *cohorts* (groups) of a thousand soldiers each. Three cohorts remained in Rome, and the others were stationed in nearby cities. Members of the guard received much higher pay than other soldiers. The praetorians eventually became so powerful they could overthrow emperors whenever they chose. Emperor Constantine finally abolished the guard in A.D. 312.

See also **Rome, Ancient** (picture: The praetorians).

**Pragmatic sanction** was a type of decree concerning church or state matters issued by European rulers. The most important pragmatic sanction was privately issued by the Habsburg Emperor Charles VI in 1713 and publicly announced in 1724. At that time, German law required rulers to pass their property on to their oldest male heirs. Charles was a member of the Habsburg family. His pragmatic sanction declared that his family's holdings could be inherited by his oldest daughter if he had no sons. It also stated that the Habsburg lands could not be divided.

Several countries recognized the decree. But Charles died without a male heir in 1740, and most of these countries soon broke their pledges. Their refusal to recognize the claim of Maria Theresa, Charles's oldest daughter, to all of her father's territories led to the War of the Austrian Succession.

See also **Maria Theresa; Succession wars** (The War of the Austrian Succession).

**Pragmatism** is a philosophy that attempts to apply the methods of science to philosophy. Its central idea is that the meaning and truth of an idea are determined by the idea's effects in practice and on conduct.

Three American philosophers—Charles Sanders Peirce, William James, and John Dewey—developed pragmatism. Peirce originated the philosophy, James made it popular, and Dewey extended it to key areas of life. Each of these men interpreted pragmatism in his own way.

Peirce first presented the basic ideas of pragmatism in a series of essays called "Illustrations of the Logic of Science" (1877-1878). He conceived of belief as something on which we are prepared to act, not just as a state

of mind. He defined belief as a *habit* or *rule of action.* He called doubt (the opposite of belief ) an unsatisfactory state from which we struggle to free ourselves. For Peirce, thinking, or *inquiry,* was the struggle to eliminate the irritation of doubt. Peirce thus regarded inquiry as a practical activity—not just something that goes on in our heads. Inquiry aims to eliminate doubt by arriving at a settled belief.

Peirce's writings were technical and attracted little attention when they were published. Pragmatism as a philosophical movement began in 1898, when William James restated Peirce's ideas in more popular language. According to James's interpretation of Peirce, the concrete meaning of any abstract or general proposition can be traced to a particular concrete consequence in our future practical experience. Thus, supposedly different ideas that have identical consequences in practice are really the same idea expressed in different words.

James's interpretation of pragmatism stated that the meaning of an abstract idea is determined by the idea's effects on one who believes it. James wrote that a true idea is one that can be verified, that "works," and that satisfies. According to this concept, truth is changeable. Because a true idea is one that agrees with reality, James concluded that we can make ideas true by our actions and change the world in which we live.

John Dewey was greatly influenced by the English biologist Charles Darwin and Darwin's theory of evolution. Dewey conceived of thought and of the mind as instruments developed in the course of evolution to allow human beings to reshape their environment. Dewey's version of pragmatism, later called *instrumentalism,* stated that all ideas are instruments. Therefore, true ideas are those that work best for attaining human goals. Dewey urged that philosophy become a tool for dealing with the specific problems of all human beings rather than with the remote problems of philosophers. Dewey advocated that the method of science be used to reshape education, morals, politics, and society.

Pragmatism became the most important philosophical movement in the United States during the early 1900's, and it has had an enormous influence on American life. Pragmatism has been called a typically American philosophy because of its basic optimism, its emphasis on action, and its belief in a future that can be changed by human ideas and efforts.

See also **James, William.**

**Prague** (pop. 1,189,828) is the capital and largest city of the Czech Republic and an important centre of culture and learning. Prague, called Praha in the Czech language, is one of the oldest and most beautiful cities in central Europe. It lies on the Vltava River, in the central part of the country (see **Czech Republic** [map]). Prague has been called the "City of a Hundred Spires" because of its many churches. It was one of the few central European cities that escaped major damage during World War II (1939-1945).

**The city** lies on both banks of the Vltava River. A number of bridges connect the two sections of Prague. The Charles Bridge, a stone structure lined with statues of saints, is the most famous one. The city of Prague covers about 180 square kilometres. Much of the city's area is made up of scenic hills.

Prague Castle, once the home of the kings of Bohemia, stands on *Hradčany* (Castle Hill), on the left bank of the Vltava River. Prague Castle houses a number of art treasures, and part of the castle serves as the official residence of the president of the Czech Republic. St. Vitus' Cathedral also stands on Hradčany. Many beautiful old palaces and other structures line the narrow, winding streets of Malá Strana, a district of Prague that is located on the slopes and at the bottom of the hill.

**Prague's Old Town Square** is lined with historic buildings. A memorial to religious reformer John Hus is in the foreground.

Old Town, the historic centre of Prague, lies on the right bank of the Vltava, across from Hradčany. Old Town Hall and the Týn Church are in Old Town Square. Old Town Hall, built during the 1300's, served as the seat of the city government for hundreds of years. It has a famous clock with statues of the 12 apostles that move every hour. A monument to John Hus, a religious reformer of the early 1400's, stands in the middle of the square. The Týn Church was the main church of the Hussite reformers (see **Hus, John**). Many buildings of Charles University, founded in 1348 by King Charles IV of Bohemia, are in Old Town.

The business centre of Prague is in New Town, also located on the right bank of the river. Much of the New Town area was built during the 1800's. Its Wenceslas Square—which is actually a wide boulevard lined with hotels, restaurants, and shops—is the busiest street in Prague. The National Museum occupies one end of Wenceslas Square. A statue of Saint Wenceslas stands in front of the museum. Prague also has many other museums, as well as libraries, theatres, opera houses, and concert halls.

Residential neighbourhoods lie north, south, and west of Prague. Factories have been built chiefly in the eastern and southern suburbs.

**People.** Most of Prague's people are Czechs. The city had a large German community before World War II, but most of the Germans were expelled after the war. Because of government restrictions on migration to Prague and a low birth rate, the size of the population has increased only slightly since the war ended.

Prague has a housing shortage. Many houses in the city were built during the early 1900's and are in poor condition. Since the mid-1900's, the government has constructed many buildings in the suburbs. But many people still live in crowded city apartments.

**Economy.** Prague ranks as one of the country's leading manufacturing centres. The city's most important industrial products include aircraft engines, beer, cars, chemicals, diesel engines, furniture, machine tools, optical instruments, processed food, and trams. Prague also serves as an important railway centre.

**History.** Prague was probably founded during the A.D. 800's. It soon grew into an important trading centre. In time, the city became the residence of the Bohemian kings, who were crowned in St. Vitus's Cathedral. King Charles IV, who also ruled the Holy Roman Empire, erected many important buildings. He founded the first university in central Europe in Prague in 1348. The Hussite religious reformation began in Prague during the 1400's, and Prague suffered much damage in the religious wars that followed.

The Thirty Years' War began in Prague in 1618 after Protestant Bohemians rebelled against the Roman Catholic Habsburg (or Hapsburg) emperor. The revolt failed, and the Habsburgs ruled Prague until the end of World War I in 1918. That year, the city became the capital of the new nation of Czechoslovakia.

German troops occupied Prague during World War II. Many of Czechoslovakia's people, including thousands of Jews, were killed by the Germans. In 1945, at the end of the war, the Soviet Army entered Prague. The Czechoslovak Communist Party, supported by the Soviets, took control of Czechoslovakia in 1948.

For a brief period in 1968, Prague was the centre of a liberal reform movement, sometimes called the *Prague Spring,* in Czechoslovakia. The movement ended after tanks and soldiers from the Soviet Union and several other Eastern European Communist countries swept into Prague.

In the late 1980's, Prague was also the centre of the movement that led to the end of Communist control of Czechoslovakia. In 1993, the independent countries of the Czech Republic and Slovakia were formed to replace Czechoslovakia. Prague remained the capital of the Czech Republic.

**Prairie** is a region of flat or hilly land covered chiefly by tall grasses. The pioneers who first saw the flat prairies of the American Middle West described them as a "sea of grass." The wind blew gentle waves in a green carpet of grasses. In some places, the grasses grew taller than an adult. Today, fields of maize and wheat cover most of the prairie. Few prairies remain untouched by human activity.

The North American prairie extends from central Texas, in the United States, to southern Saskatchewan, in Canada. Other prairies include the Pampa of Argentina, the *veld* of South Africa, the Canterbury Plains of New Zealand, and parts of Hungary, Romania, Russia, and Ukraine.

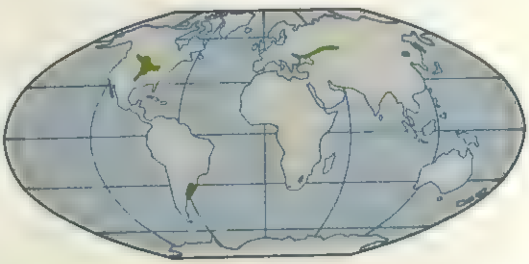
**Climate and soil.** Prairies have hot summers, cold winters, and moderate rainfall. Summer temperatures may reach well over 38 °C and winter temperatures may drop as low as −40 °C. Tropical grasslands, where temperatures vary less from summer to winter, are called *savannas* (see **Savanna**). Most prairies receive between about 50 and 90 centimetres of rain a year—less than forests get but more than *steppes* (regions of short grasses) receive. Most of the rain falls in late spring and early summer.

Prairie soils have especially deep, dark, fertile upper layers. Such soils result from the growth and decay of deep, many-branched grass roots. The rotted roots hold the soil together and also provide a source of food for living plants. The richest, blackest prairie soils are called *chernozems.* This term comes from a Russian word meaning *black earth.*

**Life on the prairie.** The thick cover of grasses of the American prairie consists of many species. Each kind of grass grows best in a certain kind of environment but

**Prairies**

The world's largest prairie lies in North America. This map also shows other large prairie regions of the world.



**Prairies** are covered chiefly by tall grasses. Few natural prairie regions remain in the world because most of them have been turned into farms or grazing land. The prairie shown on the left lies in Waterton Lakes National Park in Alberta, Canada.

also occurs in other places. For example, slough grass is found in low, marshy ground. Big bluestem, Indian grass, switch grass, and wild rye thrive in fairly moist areas. Drier areas have little bluestem, dropseeds, June grass, blue grama, needlegrasses, and side oats grama. In the moist eastern parts of the prairie, near forested areas, the grasses may grow 1.8 metres high or even taller. On the dry western edge, the grasses grow only about 60 centimetres high. There, the prairie gradually changes to a steppe.

Many kinds of nonwoody plants other than grasses also grow on the prairie. Hundreds of species of flowers add splashes of yellow, orange, red, purple, and other colours to the sea of grass. Many of these wild flowers belong to the *composite* family or to the *legume* family of plants. Composites that grow on the prairie include such flowers as asters, blazing stars, coneflowers, goldenrods, and sunflowers. Prairie legumes include clovers, psoraleas, and wild indigos. A purplish phlox and an orange-flowered milkweed called butterfly weed also colour the prairie.

Cattails and sedges rustle in the breeze in marshy areas and near the lakes and ponds of the northern prairie. Some woody shrubs, such as the prairie rose, grow among the prairie grasses. A few trees, including cottonwoods, oaks, and willows, grow in river valleys on the prairie.

Many animals feed on the leaves, roots, and seeds of prairie plants. Some of these animals, such as jack rabbits, deer and pronghorns, use their speed to escape from enemies. Others, including mice and prairie dogs, hide in underground burrows. Such birds as blackbirds, grouse, meadowlarks, quail, and sparrows build their nests in a thick cover of plants. Until the late 1800's, large herds of bison—commonly called buffaloes—roamed the American prairie.

Coyotes, foxes, and skunks feed both on smaller prairie animals and on certain plants. Badgers, hawks, owls, and some species of snakes eat meat almost entirely. Insects—especially grasshoppers and leafhoppers—and spiders are also common on the prairie.

The soil of the prairie contains millions of tiny organisms that feed on dead plants and animals. These organisms include bacteria and fungi as well as such soil animals as centipedes, earthworms, mites, and nematodes. All of them speed the process of decay among the dead plants and animals. This decaying process provides the soil with food for future generations of prairie plants.

See also **Pampa; Steppe.**

**Prairie chicken** is the name of two species of North American grouse. These birds live in the central and western plains of the United States. The *greater prairie chicken* is about 45 centimetres long and weighs about 1 kilogram. Its feathers are yellowish-brown and white above, crossed with black bars, and white and brown barred below. Its head is deep buff with brown stripes. The *lesser prairie chicken* is somewhat smaller, measuring about 40 centimetres long. Its feathers are paler than those of the greater prairie chicken.

Prairie chickens have unusual courtship habits. During courtship, the male bird erects the feather tufts on his neck, spreads and raises his tail, and stretches out his wings and allows them to droop. He inflates two pouches on the side of his throat and makes a hollow booming noise. The male also leaps and dances during the courtship period.

The number of prairie chickens has decreased greatly since the mid-1800's. Prairie chicken populations have declined chiefly because their prairie homes have been ploughed under for farmland. The lesser prairie chicken is found in the southern part of the Central Plains area, from Kansas to Texas. The greater prairie chicken now lives in isolated areas from Michigan and Illinois westward to the Great Plains. It once lived as far east as Massachusetts. Atwater's prairie chicken, a subspecies of the greater prairie chicken, lives only on the coast of Texas. The heath hen, another subspecies of the greater prairie chicken, has been extinct since the 1930's.

**Scientific classification.** Prairie chickens belong to the subfamily Tetraninae in the family Phasianidae. The greater prairie chicken is *Tympanuchus cupido;* the lesser prairie chicken is *T. pallidicinctus.*

See also **Bird** (picture: Birds of grasslands); **Grouse.**

**Prairie dog** is a burrowing rodent that lives in grassy regions of western North America. It belongs to the squirrel family. It gets its name from its warning call, which is similar to a dog's bark.

Prairie dogs have short legs; long, sharp claws; and a short, flat tail. Adult prairie dogs have light brown fur and measure from 30 to 50 centimetres in length, including the tail. They weigh from 0.5 to 1.0 kilogram.

There are two general kinds of prairie dogs— *black-tailed prairie dogs* and *white-tailed prairie dogs.* Black-tailed prairie dogs are the most common. They have black-tipped tails and live in a belt of the Great Plains from southern Canada to northern Mexico. White-tailed prairie dogs have white-tipped or grey-tipped tails. They are found in regions more than 2,000 metres above sea level from southern Montana to northern Arizona and New Mexico in the United States.

**Habits.** Prairie dogs live in burrows. They come out of their burrows only in the daytime to eat. Prairie dogs feed chiefly on green plants, especially grasses. Occasionally, they eat grasshoppers and other insects.

Prairie dogs are social animals. They live in large groups called *colonies* or *towns* that may include more than 500 members. Each colony of black-tailed prairie dogs contains many family groups known as *coteries.* A typical coterie consists of one adult male, three or four adult females, and several offspring.

A coterie stays within a specific area called a *territory.* The territory may have 50 to 100 burrows, some of them as deep as 5 metres. Most burrows have at least two entrances to provide ventilation and to help prairie dogs escape from enemies. Animals that prey on prairie dogs include badgers, bobcats, coyotes, eagles, falcons, ferrets, and hawks. Prairie dogs alert one another to danger by making loud barking or chirping noises.

Black-tailed prairie dogs mate in February or March. The female carries her young for about 34 days and then gives birth to one to six babies. The young emerge from their burrows five or six weeks after birth. Males leave the coterie after they are 12 to 14 months old, and each attempts to take over a coterie from an older male. Most females remain in the original coterie for life. About half of all black-tails die before they are 1 year old. Males that survive the first year may live five years, and females seven.

**Prairie dogs** keep a sharp lookout for their enemies. The black-tailed prairie dogs pictured here have gathered at an entrance to one of their burrows. Prairie dogs live in large groups called *colonies* or *towns.*

**Prairie dogs and people.** Many ranchers dislike the prairie dog because they fear that their livestock will step into prairie dog burrows and suffer leg injuries. However, horses and cows rarely step into burrows. In addition, ranchers believe that prairie dogs eat grasses and other plants that cattle might eat. But studies indicate that prairie dogs only occupy areas that have already been overgrazed by livestock. More research is needed to understand the relationship between prairie dogs and livestock.

**Scientific classification.** Prairie dogs belong to the family, Sciuridae. There are two species of black-tailed prairie dogs: *Cynomys ludovicianus* and *C. mexicanus.* There are three species of white-tailed prairie dogs: *C. leucurus, C. gunnisoni,* and *C. parvidens.*

See also **Animal** (picture: Animals that live together); **Gopher; Ground squirrel; Rodent; Squirrel.**

**Prambanan** is the name given to a group of Hindu temples near Yogyakarta, in central Java, Indonesia. They were built during the A.D. 800's. On moonlit nights, one of the outer courtyards of the temples is used as an open air theatre for a dramatic performance of the epic poem, *Ramayana.* See **Ramayana.**

The group consists of six buildings. The central and largest temple is dedicated to Shiva, a Hindu god. In the temple are sculptures of scenes from the *Ramayana.* The central statue in the temple is also that of Shiva. The temple also contains statues of Agastya, Durga, and Ganesha, three other Hindu gods. Other temples are dedicated to Nandi, the bull on which Shiva rides, the god Brahma, and the god Vishnu.

**Pramudya Ananta Tur** (1925- ) is one of Indonesia's greatest writers of the 1900's. He is one of the best known Indonesian writers internationally, and his work has been translated into English, Dutch, German, Spanish, Russian, and Chinese.

Pramudya was born in Blora, a small town in northern central Java, between Semarang and Surabaya. After the Japanese invasion in 1942, his father went away, and Pramudya, the eldest child, had to provide for his ten younger brothers and sisters by selling tobacco at a street stall. After his mother died, he went to Jakarta and worked for a Japanese press agency. He later joined the Indonesian army. In 1947, he went to work with the nationalists' radio station. He was arrested by Dutch soldiers and held until the end of 1949, when the Dutch left Indonesia. During his time in prison, he wrote some of his most important works, including *Keluarga Gerilya* (*Guerrilla family,* published in 1950). In 1956, he went to China, which he found progressive. As a result, his ideas on politics became closer to those of the Indonesian Communist Party. In 1965, the Communists made an unsuccessful attempt to seize control of the government. Pramudya was arrested by the Indonesian government and imprisoned on the island of Baru for 16 years. There he wrote *Bumi Manusia (This Earth of Mankind)* and three other important novels.

**Prasad, Rajendra** (1884-1963), was a prominent leader of the nationalist struggle in India. He was born in northern Bihar. Prasad was educated in Calcutta and qualified as a lawyer.

Prasad met Mohandas Gandhi in 1917. From then onward, he worked closely with Gandhi organizing the nationalist movement. From 1934 to 1936, he served as president of the Indian National Congress. When India gained independence in 1947, he became president of the Constituent Assembly. In 1950, when India's new constitution came into effect, Prasad was elected the nation's first president. He held that post until 1962.

Prasad accepted Gandhi's ideas on ethical and political questions, and was keen to preserve and develop Indian culture. This sometimes caused differences between him and Jawaharlal Nehru, India's first prime minister.

**Praseodymium** is one of the rare-earth chemical elements. Its chemical symbol is Pr, its atomic number is 59, and its atomic weight is 140.908. At 25° C, its density is 6.475 grams per cubic centimetre (see **Density**). Austrian chemist C. F. Auer von Welsbach was the first to discover praseodymium in 1885, when he separated salts of the so-called element didymium into praseodymium and neodymium. The name *praseodymium* comes from the Greek words *prasios,* meaning *leek-green,* and *didymos,* meaning *twin.* The element received this name because it occurred in the green fraction, or part, of didymium. It is best separated from the other rare-earth elements by ion-exchange or solvent extraction processes.

Praseodymium melts at 931° C and boils at 3520° C. It makes a useful alloy, especially in *misch metal* (a mixture of rare earths). Praseodymium oxide is a black powder that dissolves in acid to form green solutions or green salts. These praseodymium salts are used in the ceramics industry for colouring glasses and for glazing.

See also **Element, Chemical** (table); **Rare earth.**

**Pratap Sinha, Rana** (1540-1597), an Indian king, is regarded as a hero in the state of Rajasthan. Other nearby rulers submitted to the Mughal emperor Akbar. But Pratap fought back and refused to surrender his kingdom.

Pratap was born in the kingdom of Mewar, in modern-day Rajasthan, which was ruled by his father. In 1568, Akbar conquered Chitor, Mewar's capital. In 1572, Pratap became *rana* (king) of Mewar with the support of the elder nobles. He then began a life-long war against Akbar.

In 1576, he was defeated at the battle of Haldighat, when he faced other Rajput rulers who had become allies of Akbar. Many soldiers of Mewar were killed. Pratap escaped to the hills on his gallant horse Cheytuk.

**Pratincole** is the name given to 16 species of birds with long pointed wings and a forked tail. Pratincoles are found in southern Europe, Africa, and Asia. They live on flat, open, arid areas and also near fresh water. Pratincoles are quick and agile fliers. They eat large insects caught while flying or on the ground.

Pratincoles live in flocks of up to several hundred birds. They nest in loose colonies within which each pair maintains its territory. The female lays between 2 and 4 eggs in a nest on the ground. Both parents incubate the eggs for about 18 days.

Pratincoles are about 25 centimetres long. They have brownish plumage and a creamy patch on the throat, edged with black. The *collared pratincole* has red-brown patches under its wings. It has a widespread distribution, from the Mediterranean, through the Middle East, to India. The *Australian pratincole* is a long-legged species.

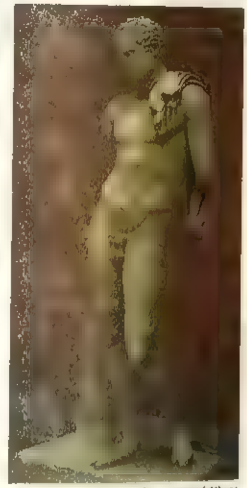
**Scientific classification.** Pratincoles belong to the family Glareolidae. The collared pratincole is *Glareola pratincola.* The Australian pratincole is *Stiltia isabella.*

**The collared pratincole** often nests on sun-baked salt flats. It feeds on insects, taken in flight and also on the ground.

**Pravda** was the official newspaper of the Communist Party of the Soviet Union until the Communist Party lost control of the Soviet government in 1991. Pravda was established in 1912, in St. Petersburg, where Lenin was one of its chief contributors (see **Lenin, V.I.**). At its peak the newspaper was one of the most widely circulated in the world.

**Prawn.** See Shrimp.

**Praxiteles** was one of the greatest Greek sculptors of the 300's B.C. He was one of the first sculptors to humanize the Greek gods and goddesses, a departure from the stern, remote, awe-inspiring figures of previous Greek sculptors.



National Museum of Athens

**Hermes** is a Roman copy of a statue by Praxiteles. It shows the sculptor's lifelike style.

Praxiteles excelled in sculpting the beauty of the human form. Face and body features were delicately lifelike, and the marble surfaces had a lustrous finish. The eyes of his figures had a dreamy look. The hip was often thrust out, creating a graceful "S" curve, and giving the body a more relaxed stance.

Although none of Praxiteles' work has survived, Greek and Roman copies of his sculptures exist that are excellent representations of his style. One famous copy is a statue of Hermes and the infant Dionysus (see **Hermes**). Praxiteles was born in Athens.

**Prayer** refers to reverent words and thoughts directed toward God, gods, goddesses, or other objects of worship. People pray to ask for spiritual benefits for themselves or others. They also offer praise, thanksgiving, or adoration to the object of worship. Prayers may take the form of speech, song, dance, or silent reverence. Some people kneel while praying. Others stand, sit, or lie on the ground. Prayer is an important form of worship in nearly all the world's religions. Most religions have regular prayers for both community and private worship. Individuals may also offer private prayers that express personal thoughts. *Contemplation* is prayer in which a person concentrates only on the object of worship.

See also **Religion** (Religious rituals); **Lord's Prayer.**

**Prayer Book** is the service book of the Church of England. Its full title is the Book of Common Prayer.

When the English Reformation rejected Roman Catholicism, a need arose for a book of services suited to Protestant principles. Roman Catholic services were in Latin and could be understood only by priests and by a few educated people. For this reason, the new Prayer Book was in English. In 1549, an Act of Uniformity established, as the official service book, a Prayer Book composed mainly by Thomas Cranmer (see **Cranmer, Thomas**). A second Act of Uniformity, in 1552, revised it.

Under the reign of Queen Mary (1553-1559), the Prayer Book was withdrawn, but Elizabeth I restored it in 1559 with some amendments. The Puritans believed that

many of the ceremonies in the Prayer Book had no authority from the Bible and, in 1645, during the English Civil War, they suppressed it. Charles II restored it in 1660, and, in 1662, an Act of Uniformity established the version in use today. The Church Assembly devised a Revised Book in 1927. The House of Commons rejected it, but parts of it are used. In 1965, Parliament gave the Church of England the right to arrange its own forms of worship without political interference. In 1980, the *Alternative Service Book* was introduced, authorizing services for use in the Church of England in conjunction with the Prayer Book.

**Praying mantis.** See **Mantid.**

**Preamble.** See **United Nations** (The preamble to the United Nations Charter).

**Precambrian time.** See **Earth** (The earth's earliest history).

**Precession.** See **Gyroscope** (Gyroscopic properties).

**Precession of the equinoxes.** See **Equinox.**

**Precious stone.** See **Gem.**

**Precipitation.** See **Hail; Rain; Sleet; Snow; Weather.**

**Precipitator.** See **Air cleaner.**

**Precision skating.** See **Ice skating** (Precision skating).

**Predator.** See **Balance of nature.**

**Predestination** is the belief that God foresees and wills from all eternity that some individuals will be saved. Other terms for predestination include *election* and *foreordination.* The belief that God predestines some people for salvation and others for damnation is called *double predestination.* Both Christianity and Islam include a belief in predestination. This article deals with predestination in Christianity.

The doctrine of predestination has been a problem in Christian theology since the time of Saint Augustine, in the early 400's. The problem arises from the apparent conflict between the beliefs that God is all-powerful and that human beings have free wills. Some theologians have stressed the importance of human freedom, and others have emphasized God's power and grace in salvation. Augustine wrote that salvation is initiated only by God's freely given grace. In the 1500's, Martin Luther and other leaders of the Protestant Reformation taught that salvation depends entirely on God's all-powerful will. They believed that nothing humanity did could require God to grant salvation in return. The Protestant leader John Calvin taught the doctrine of double predestination.

Some people have criticized the doctrine of predestination as being negative and pessimistic. However, Luther, Calvin, and others saw it as a doctrine that should free people from constantly worrying about and struggling to earn salvation. Because salvation is in God's hands, they believed, the individual should stop being anxious and simply trust in God.

See also **Free will; Grace.**

**Predicate.** See **Sentence** (Subject and predicate).

**Preeclampsia.** See **Toxaemia of pregnancy.**

**Preferential voting** is the process used in federal and state parliamentary elections in Australia. In *marking* a ballot, the voter indicates the order of his or her preference for the candidates by writing the numbers *1, 2, 3,* and so on, beside their names. There are several methods of *counting* the ballots.

The *alternative vote* system is used for counting votes in elections for the House of Representatives and for all state elections except the Tasmanian lower house. This system gives the voter an alternative choice of candidates if his or her earlier choices are excluded at various stages of the count.

When electoral officers count the votes for the first time, they count only the first preference marked on each paper. If one candidate receives more than half the total number of first preferences, he or she is elected. If not, the electoral officers exclude the candidate who received the smallest number of first preferences. They take the ballot papers for that candidate and distribute them among the remaining candidates according to the second preferences, continuing until one candidate gains more than half the votes.

A system of *proportional representation* is used in counting votes in Senate elections. After determining the total number of valid ballots, electoral officers set a *quota* (the minimum number of votes needed to gain election). A candidate who receives the quota is elected. Any votes for this candidate above the quota are distributed to the remaining candidates according to the voters' second preferences. If all the vacancies are not filled after distribution, the candidate with the fewest votes is excluded, as in the alternative vote system. This process continues until sufficient candidates have been elected to fill all the vacancies.

A feature of proportional representation is that the number of candidates elected for a particular political party will be proportional to the number of votes cast for that party in a particular state. As a result, the system enables smaller parties and independent candidates to be represented in the Senate.

The *Hare Clark* system of proportional representation, used in elections for the Tasmanian lower house, is a variant of the system used for Senate elections.

In early parliamentary elections in Australia, the *first-past-the-post* voting process was used. This process is still used in many other countries, including Britain and New Zealand. This form of voting requires the voter to indicate a vote for only one candidate. In 1892, Queensland became the first Australian state to introduce an alternative vote system. The Australian federal government first introduced the alternative vote in 1919.

**Pregnancy** is the period during which a woman carries a baby within her body before giving birth. Pregnancy begins with *conception*—that is, the fertilization of an egg by a sperm, and it ends with *labour,* the birth process. The fertilized egg is called a *zygote.*

Pregnancy, also called *gestation,* lasts about nine months for most women. The females of almost all other species of mammals also have a period of pregnancy. The period varies in length among different animals (see **Animal** [table: Names of animals and their young]). This article discusses human pregnancy.

**The baby during pregnancy.** The developing zygote is called an *embryo* during the first two months of pregnancy, and a *fetus* thereafter. During the second week after conception, the membranes that surround the embryo become attached to the lining of the uterus. A structure called the *placenta* forms in the uterus. The placenta enables the embryo to live within the mother's body. Food and oxygen pass from the mother's blood-

stream to the embryo or fetus by means of the placenta. The embryo is attached to the placenta by a tubelike structure called the *umbilical cord.* After two months, the fetus is about 2.5 centimetres long and can move its head, mouth, arms, and legs.

The fetus has recognizable human features after three months. The mother may first feel the fetus moving inside her during the fifth month. After six months, the fetus measures about 30 centimetres long and weighs from 0.5 to 0.7 kilogram. Most of its organs are functioning. During the last three months of pregnancy, the mother's bloodstream provides various immune substances that help protect the baby from various diseases after birth.

**How pregnancy affects women.** Pregnancy causes physical changes in women. Menstruation stops and does not resume until after a woman has given birth. During the first three months of pregnancy, the mother may suffer *morning sickness* (nausea and vomiting). Pregnant women gain an average of 9 to 11 kilograms. The fetus at birth accounts for about 2.9 to 3.6 kilograms of this weight, the placenta for about 0.5 to 0.7 kilogram, and the breasts for about 0.5 kilogram.

The mother's breasts change in many ways during pregnancy. For example, the nipples become larger and the area around them turns darker. Breasts also increase in size so that they can provide an adequate supply of milk. These and other changes make it possible for the mother to nurse the baby after it is born.

Women should have regular medical care during pregnancy. Substances in a woman's bloodstream may enter a developing baby's bloodstream through the placenta. To prevent damage to the embryo, doctors advise pregnant women not to smoke, drink alcoholic beverages, or take certain medications. In addition, women who are 35 years of age or older and those who have certain genetic disorders in their family histories may be advised to seek genetic counselling. One of the most serious conditions that may occur in the later months of gestation is *toxaemia of pregnancy.* Its symptoms include headache, sudden and excessive weight gain, and swelling of the face and hands. A woman with these symptoms should seek medical help.

**Miscarriage,** also called *spontaneous abortion,* is the unintentional early ending of pregnancy by a natural cause. Physical problems may occur in the woman's body that cause the fetus to die and be expelled from the uterus. Defects in the egg or sperm are another cause of miscarriage. Medical treatment before and during pregnancy can significantly reduce the risk of a miscarriage occurring.

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Childbirth
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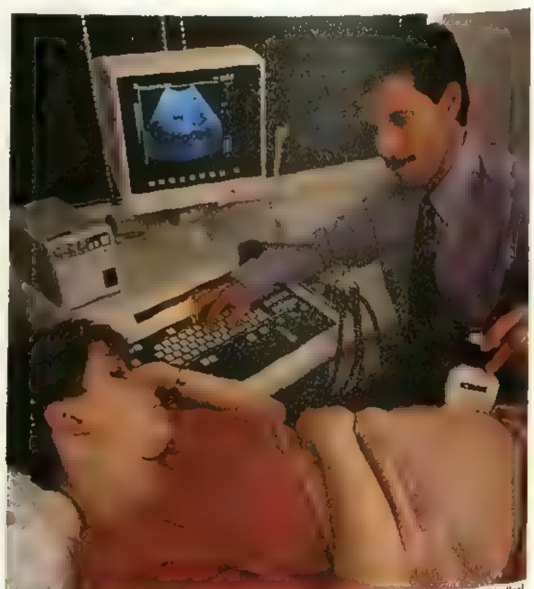
Miscarriage
Placenta
Reproduction
Toxaemia of pregnancy

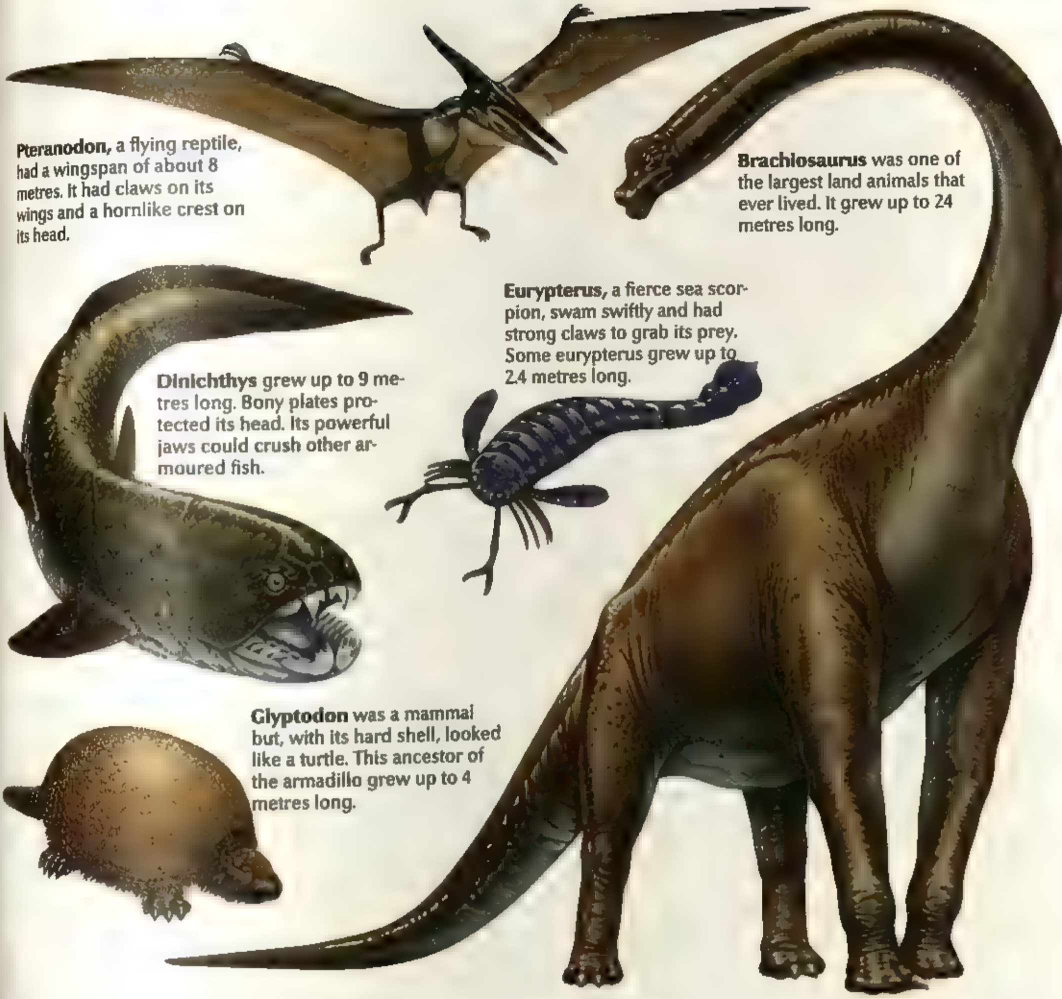
Martin, Custom Medical

**Lamaze classes** help pregnant women and their partners prepare for the birth of their child. Special exercises teach the mothers techniques which help reduce fatigue during the birth.



Kevin Beebe, Custom Medical

**A pregnant woman** and her unborn baby undergo a regular checkup. An ultrasound scanner shows a doctor an image of the fetus so the progress of the pregnancy can be monitored.



**Pteranodon,** a flying reptile, had a wingspan of about 8 metres. It had claws on its wings and a hornlike crest on its head.

**Brachiosaurus** was one of the largest land animals that ever lived. It grew up to 24 metres long.

**Eurypterus,** a fierce sea scorpion, swam swiftly and had strong claws to grab its prey. Some eurypterus grew up to 2.4 metres long.

**Dinichthys** grew up to 9 metres long. Bony plates protected its head. Its powerful jaws could crush other armoured fish.

**Glyptodon** was a mammal but, with its hard shell, looked like a turtle. This ancestor of the armadillo grew up to 4 metres long.

# Prehistoric animal

**Prehistoric animal** is any animal that lived more than 5,500 years ago—that is, before people invented writing and began to record history. Some prehistoric animals resembled animals alive today. But others were unlike any living animals. They included huge dinosaurs that may have measured up to about 45 metres long and flying reptiles with a wingspan of up to 12 metres. Other fantastic animals were toothed birds with claws on their wings; fish covered with bony armour; and pig-sized, trunkless ancestors of the elephant. Not all the different prehistoric animals lived at the same time.

The story of prehistoric animals is told by *fossils.* Fossils are shells, bones, animal tracks, outlines of leaves, and any other preserved traces of prehistoric life. Fossils help scientists tell what prehistoric animals looked like. They also give information about when, where, and how these animals lived.

The oldest known animal fossils are about 700 million years old. However, most scientists who study prehistoric animals believe that the first simple animals lived millions of years earlier. They think that from these simple creatures more complicated animals gradually developed over millions of years.

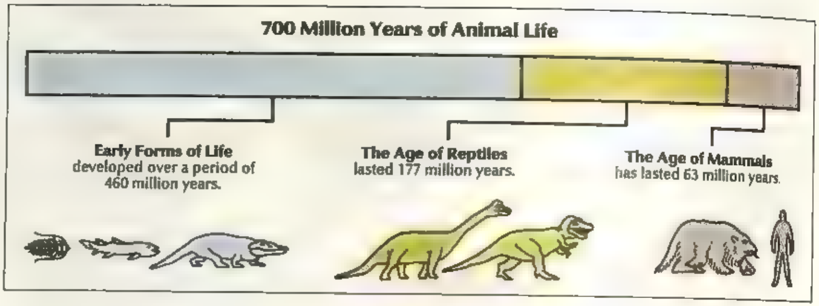
### The world of prehistoric animals

Prehistoric animals lived mainly during three major periods in the earth's history called *eras.* The *Palaeozoic Era* lasted from about 570 million to 240 million years ago. The *Mesozoic Era* lasted from about 240 million to 63 million years ago. The *Cenozoic Era,* the present era, began about 63 million years ago. Throughout each era, great changes occurred in the kinds of animals and plants living on the earth.

The three eras are further divided into shorter periods. Different layers of rock formed in the earth's crust during each period. These rocks tell scientists about changes in the surface features and climate of the earth. From the rocks and the fossils found in them, scientists are able to determine which animals lived during each period.

### The development of animal life

The oldest known animal fossils are about 700 million years old. Through the ages, animals grew increasingly complicated, and many new kinds appeared. At certain times in the earth's history, one particular group of animals, such as reptiles or mammals, increased in size and variety and became dominant.




When animal life began on the earth, the earth looked very different from the way it does today. No plants grew on the bare, rocky land, and most mountains and valleys had not yet formed. Shallow seas covered much of the earth. It was in these seas that animal and plant life arose.

Conditions on the earth changed throughout the time that prehistoric animals lived. The land masses slowly drifted together, formed one huge continent, and then broke apart again. Mountains gradually rose and wore down. At various times, seas spread over vast land areas and then shrank back. The climate turned alternately warmer and colder and wetter and drier. New kinds of plants developed that met the changing conditions. Animals responded to the changes in plant life and the earth's features by slowly changing, too. New groups of animals arose that were better suited to the new conditions. Older groups became *extinct* (died out) when they could not survive changes in their *environment* (surroundings.)

## Early forms of animal life

The first living things on the earth were probably bacteria and other primitive organisms that arose more than 3½ billion years ago. The oldest known fossils are of bacteria about 3½ billion years old.

Prehistoric animals depended on green plants, just as animals do today. Only green plants can use the sun's energy to produce food (see **Photosynthesis**). Animals must eat either plants or other animals that have eaten plants. Animal life developed only after plants were available as food.

**The first animals** were one-celled organisms that lived in the sea. These microscopic animals swam about by means of a whiplike tail. In time, animals made up of many cells *evolved* (developed gradually). Groups of cells eventually began to serve different functions. These cells became organized into structures for feeding, reproducing, moving about, and sensing changes in the environment.

As prehistoric animals became more complicated, they grew larger. The larger animals needed a skeleton. A skeleton gives an animal a fixed shape and supports its muscles. The first skeletons were shells and other tough outer frames, or *exoskeletons.*

Nearly all the major types of *invertebrates* (animals without backbones) had come into being by the end of the Cambrian Period, about 500 million years ago. All animals still lived in the sea. Some, such as worms and jellyfish, had soft bodies. Other animals had hard outer skeletons. They included starfish and such molluscs as snails. The most advanced early invertebrates were flat shellfish called *trilobites,* which crawled along the bottom of the sea. Trilobites were related to such later animals as insects, crabs, shrimp, and spiders.

**Animals with backbones** are called *vertebrates.* They were the last major group of prehistoric animals to evolve. A vertebrate has several advantages over an invertebrate because it has a skeleton made of bones inside its body. Such a skeleton weighs less than an outer skeleton. An internal skeleton also enables the animal to move more freely.

A few simple vertebrates had appeared by the end of the Cambrian Period. They were fish without jaws or teeth. Jawless fish fed by sucking tiny pieces of dead animal material from the sea floor. Fish developed jaws and teeth about 420 million years ago. Jawed fish could capture and eat larger animals, and they moved about more freely than jawless fish.

So many kinds of fish appeared during the Devonian Period that it is often called the *Age of Fishes.* The period began about 410 million years ago. All Devonian fish had a heavy armour of bony plates and scales. Most Devonian fish eventually died out. But some, including the first sharks and ray-finned fish, have modern relatives. One group of Devonian fish had rounded, fleshy fins. These *lobe-finned fish* probably were ancestors of the first vertebrates that lived on the land.

**The move onto land** was a huge advance in the development of prehistoric animals. Plants appeared on land first, about 430 million years ago. They thus provided food for the animals that came later. The first land animals included primitive forms of insects and spiders. For vertebrates, life on land required major adjustments. They had to breathe with lungs rather than gills. They also had to support their bodies against the pull of gravity. But life on land also had a number of advantages. Oxygen is far more concentrated in air than in water. In addition, there were no enemies to prey on the first land animals.

Lobe-finned fish were well suited to experimenting with life on land. They lived in shallow pools and had developed lunglike pockets in their throats for breathing air. Their sturdy fins enabled them to crawl along the pool bottom or over land for short distances. Most scientists believe that the fins of these fish developed into the legs of land animals.

The first vertebrates to live on land were *amphibians,* ancestors of today's frogs, toads, and salamanders. They appeared near the end of the Devonian Period. The early

amphibians had heads and tails like those of fish. But they also had short legs in place of fins and thick skin that kept their bodies from drying out. They could stay out of water for long periods. They returned to water to lay their eggs, just as most amphibians do today.

The size and variety of prehistoric land animals increased greatly during the last 100 million years of the Palaeozoic Era. Some amphibians grew as long as 4.6 metres. The many kinds of insects included dragonflies with a wingspan of about 70 centimetres and cockroaches 10 centimetres long. But the major advance was the appearance of reptiles.

### The Age of Reptiles

The first reptiles were lizardlike creatures that developed about 330 million years ago, near the end of the Mississippian Period. Reptiles evolved from amphibians and resembled them. But reptiles had an important advantage—they could lay their eggs on land. A tough shell prevented reptile eggs from drying out, and special membranes enabled the young to develop inside the eggs. Reptiles thus depended less on water than amphibians did and could lead more active lives on land.

The earth's climate grew warmer and drier during the Permian Period, which began about 290 million years ago. Many inland seas dried up, and deserts spread over large areas. Reptiles adapted to the new conditions, and many new types evolved. But large amphibians slowly died out. Reptiles had become the dominant animals by the time the Mesozoic Era started about 240 million years ago. They dominated the land, sea, and air during the 177 million years of the era, which is commonly called the *Age of Reptiles.*

**Dinosaurs** were the most spectacular Mesozoic reptiles. There were many kinds of dinosaurs, and they varied greatly in size. Some dinosaurs were the largest animals ever to live on land. The smallest kinds were about the size of chickens. Scientists once thought that dinosaurs were slow, clumsy animals. But they now believe that at least some kinds could run fairly fast.

One of the largest known dinosaurs was the *Seismosaurus,* which may have measured about 45 metres long.

**Animals of the Palaeozoic Era** Many early forms of animal life developed during the Palaeozoic Era, which lasted from about 570 million to 240 million years ago. The era is divided into seven periods. During the first three, all animals lived in the sea. Later, insects, amphibians, and reptiles appeared on land.


| Period | Cambrian | Ordovician | Silurian | Devonian | Mississippian | Pennsylvanian | Permian |
|---|---|---|---|---|---|---|---|
| Animal Life | Trilobites were common in the sea. Jawless fish appeared. Land was bare. | Molluscs and coral were plentiful in the sea. Algae became common. | Fish developed jaws. Plants appeared on land. | Fish were plentiful. Insects and amphibians appeared. | Crustaceans, fish, and amphibians were plentiful. Reptiles appeared. Huge, swampy forests grew. Giant insects lived in the forests. | | Seed plants appeared. Trilobites died out near the period's end. |
| Began | 570 million years ago | 500 million years ago | 435 million years ago | 410 million years ago | 360 million years ago | 330 million years ago | 290 million years ago |
| Lasted | 70 million years | 65 million years | 25 million years | 50 million years | 30 million years | 40 million years | 50 million years |

It ate only plants. The worst enemies of plant-eating dinosaurs were meat-eating dinosaurs, such as *Tyrannosaurus.* By about 63 million years ago, all dinosaurs had died out. Scientists do not know why. But some believe an asteroid hit the earth. The impact of the asteroid could have caused fires worldwide. Dust from the asteroid and soot and smoke from the fires could have kept sunlight from reaching the earth, thereby lowering temperatures and killing the plants that dinosaurs ate. See **Dinosaur.**

**Other reptiles.** While dinosaurs ruled the land, giant reptiles also ruled the seas and the air. Like dinosaurs, they died out at the end of the Mesozoic Era. But smaller reptiles, including crocodiles, lizards, snakes, and turtles, continued into modern times.

Several kinds of marine reptiles lived in the Mesozoic seas. *Ichthyosaurs* resembled porpoises. *Plesiosaurs* were like enormous whales. *Mosasaurs* were gigantic sea lizards that grew up to about 9 metres long.

Flying reptiles called *pterosaurs* were the first vertebrates to conquer the air. Some pterosaurs were no larger than sparrows. Others were huge creatures with a wingspan of 8 metres. Pterosaurs had no feathers, but they may have had hair on the membranes of skin that formed their wings.

**Invertebrates** continued to multiply and evolve during Mesozoic times. Many kinds of molluscs flourished in the seas. They included the spiral-shelled ammonite and ancestors of snails, clams, and squids. Such crustaceans as lobsters, crabs, and shrimp also thrived in Mesozoic seas. Most present-day groups of insects had appeared by the end of the era.

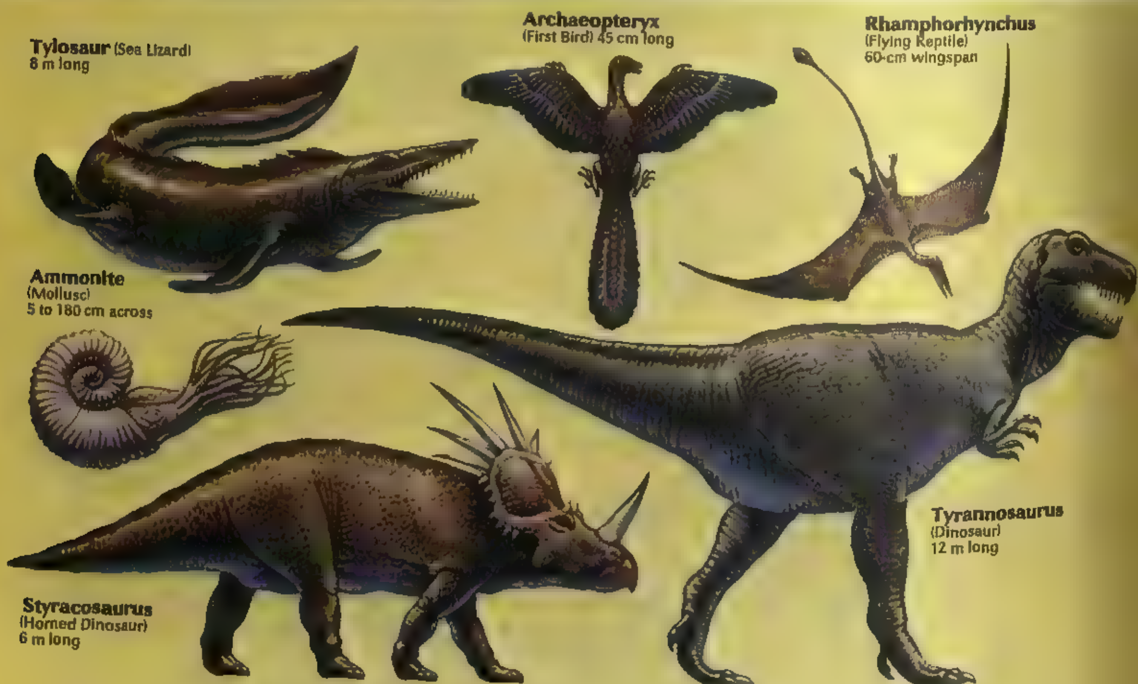
**Fish** were plentiful during the Age of Reptiles. The first modern bony fish appeared during the Triassic Period, which began about 240 million years ago.

**Amphibians.** By the end of the Triassic Period, about 205 million years ago, the larger amphibians had died out. But smaller amphibians lived on and became the ancestors of modern frogs, toads, and salamanders.

**Birds** evolved from dinosaurs during the Mesozoic Era. The oldest known bird was *Archaeopteryx.* It lived about 140 million years ago, during the late Jurassic Pe-

**Animals of the Mesozoic Era**

Reptiles dominated the land, sea, and sky during the Mesozoic Era, which is also known as the *Age of Reptiles.* The era lasted from 240 million to 63 million years ago. It is divided into three periods. Many of the reptiles, including the dinosaurs, died out at the end of the era.




| | | | |
|---|---|---|---|
| **Animal Life** | The first turtles, crocodiles, dinosaurs, sea reptiles, flying reptiles, and mammals appeared. The huge supercontinent began to break up into separate continents. | The first birds appeared. Dinosaurs reached their greatest size. Insects were plentiful. Ammonites flourished in the sea. A few small mammals lived on land. | Horned and armoured dinosaurs became common. Flowering plants developed. Dinosaurs, flying reptiles, and giant sea reptiles died out at the end of the period. |
| **Period** | Triassic | Jurassic | Cretaceous |
| **Began** | 240 million years ago | 205 million years ago | 138 million years ago |
| **Lasted** | 35 million years | 67 million years | 75 million years |

riod. This bird was about the size of a crow and resembled a reptile in many ways. It had teeth, a reptilelike tail, and claws on each wing. But it was covered with feathers. Prehistoric birds left few fossils because their fragile skeletons were easily crushed.

**Mammals,** like birds, evolved from reptiles during the Mesozoic Era. They arose from a group of reptiles that gradually developed mammallike skulls, teeth, and bones. The early mammals were small animals, about the size of rats, with furry bodies and pointed snouts.

Some Mesozoic mammals laid eggs. Only two kinds of egg-laying mammals survive today. They are platypuses and echidnas, which live in Australia and New Guinea. The most important Mesozoic mammals were *marsupials* and *placentals.* Such mammals give birth to live young. Marsupials, which include kangaroos and opossums, give birth to poorly developed offspring. Among nearly all marsupials, the young continue to develop in the mother's pouch. Placentals give birth to fairly well-developed young. The young develop inside the mother's body and receive nourishment from an organ called the *placenta.* Placentals became the dominant animals in the next era of the earth's history.

## The Age of Mammals

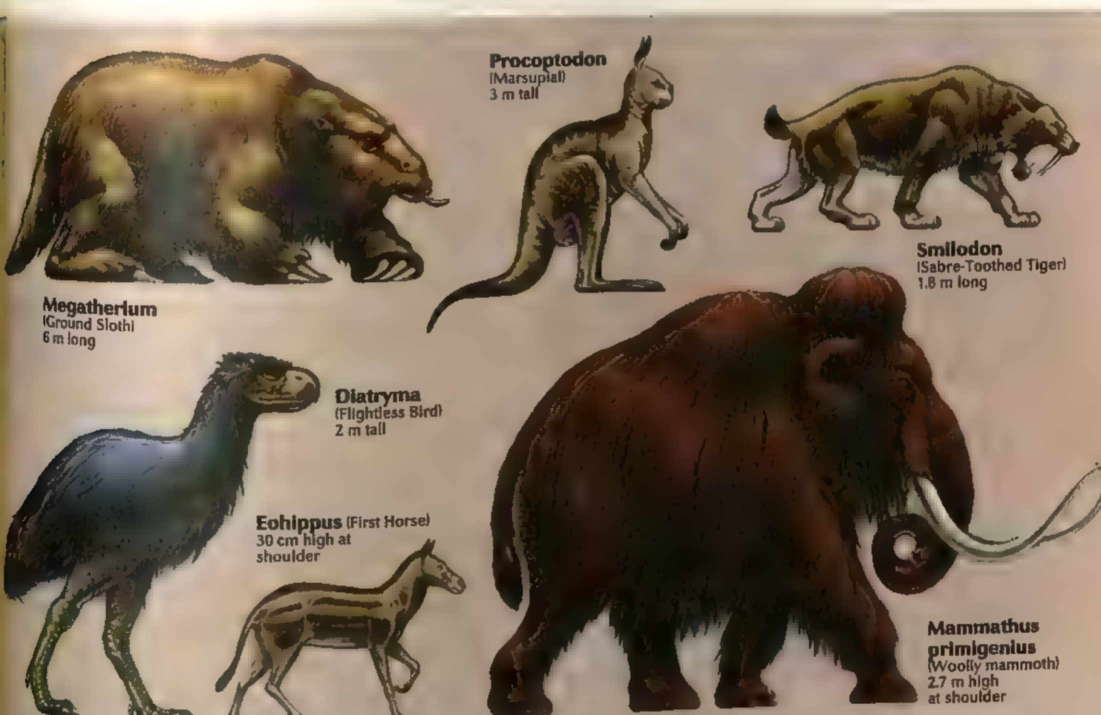
Mammals began to rule the earth after the dinosaurs and other giant reptiles had died out at the end of the Mesozoic Era. The Cenozoic Era, which followed the Mesozoic Era, is also known as the *Age of Mammals.* It began about 63 million years ago and continues today.

During early Cenozoic times, conditions on the earth were excellent for the rapid development of many kinds of mammals. New types of living places were created for them as mountains rose and lowland swamps dried up. Being warm blooded and covered with hair, mammals could adapt more easily than other animals to the cool, dry climate of the early Cenozoic Era.

**The development of placentals.** The first placental mammals were small animals that fed mainly on insects. Larger plant-eating and meat-eating placentals evolved from them.

The ancestors of many modern placentals appeared

**Animals of the Cenozoic Era** Mammals became the dominant animals during the Cenozoic Era, which is also known as the *Age of Mammals.* The era began about 63 million years ago and continues today. It is divided into two periods and seven epochs. Human beings have lived during only about the last 2 million years.




| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Animal Life** | The kinds of mammals expanded rapidly. | First camels, horses, and other mammals appeared. | Grassland spread. Primitive apes appeared. | Mammals reached their greatest variety. | Humanlike creatures and many other modern mammals appeared. | Modern human beings developed. The Ice Age began. | Human beings hunted and tamed many animals. |
| **Period** | Tertiary | | | | | Quaternary | |
| **Epoch** | Palaeocene | Eocene | Oligocene | Miocene | Pliocene | Pleistocene | Holocene |
| **Began** | 63 million years ago | 55 million years ago | 38 million years ago | 24 million years ago | 5 million years ago | 2 million years ago | 10,000 years ago |
| **Lasted** | 8 million years | 17 million years | 14 million years | 19 million years | 3 million years | 2 million years | 10,000 years |

**The study of fossils** enables scientists to learn about prehistoric animals. Before removing bones from the ground, the scientist above dusts them off and numbers them in order. Back in the laboratory, *below*, he uses a tool to clean a mammal skull.

early in the Cenozoic Era. They remained relatively small. For example, the first horse, *Eohippus*, and the first camel, *Protylopus*, were about the size of a fox. *Miacis*, an ancestor of such animals as the dog, cat, bear, and wolf, was about as big as a weasel. *Moeritherium*, an ancestor of the elephant, was about as large as a pig and lacked a trunk and tusks. Other mammals that lived during the early Cenozoic times included the first members of the monkey family and the first rodents, the ancestors of squirrels, mice, and beavers.

By the middle of the Cenozoic Era, many mountain ranges had worn down, depositing rich topsoil on the plains at their bases. New kinds of grasses grew on the fertile plains. In that environment, the ancestors of modern hoofed mammals, such as horses, deer, pigs, and camels, became plentiful. They also grew larger. For example, horses evolved into animals the size of goats. The increase in hoofed animals provided more prey for meat-eating mammals. These *predators* included sabre-toothed tigers, which killed their prey with two fanglike teeth that measured 20 centimetres long. In Asia and Africa, some monkeys evolved into the first apes. The number and kinds of rodents multiplied, and they became the most important small mammals.

The climate grew cooler in the late Cenozoic Era and led to the Ice Age, which is commonly dated between 2 million and 10,000 years ago. During the Ice Age, glaciers advanced and retreated several times over large areas of the earth. Huge, lumbering mammoths and woolly rhinoceroses roamed the frozen land. Their thick, shaggy coats helped them adapt to the cold.

Many kinds of prehistoric mammals had become extinct by the time the last glaciers retreated about 10,000 years ago. They included ground sloths, mammoths, sabre-toothed tigers, and woolly rhinoceroses. Scientists disagree whether these animals were killed off by changes in climate and plant life or whether human beings were responsible.

Prehistoric human beings lived during only a very small part of the earth's history. Most scientists believe that prehistoric people evolved from humanlike apes that appeared more than 4 million years ago.

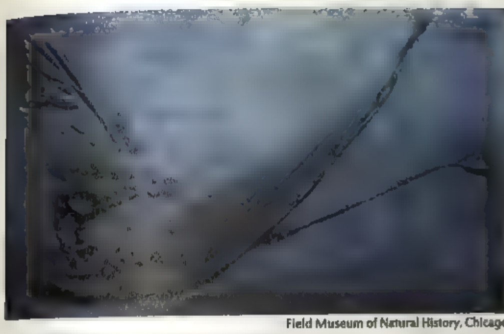
**The distribution of mammals.** By about 250 million years ago, all the continents had slowly drifted together into one supercontinent. About 200 million years ago, this huge land mass began to break up again into separate continents, which slowly drifted to their present locations. Placental mammals arose in the northern parts of the land mass. Few of them had spread to Australia and South America by the time those continents broke off from the supercontinent. As a result, a wide variety of marsupials evolved in Australia and South America, where they did not have to compete with the more advanced placentals for food and nesting places. On the other continents, competition from placentals quickly killed off the marsupials.

Many prehistoric marsupials developed forms like those of certain placental mammals. For example, Australia's marsupials included the rodentlike opossum, the piglike wombat, and the wolflike Tasmanian devil. Fast-moving kangaroos were the marsupial equivalent of the hoofed placentals that roamed the plains of North America. One kind of marsupial in South America closely resembled the sabre-toothed tiger.

Prehistoric placental mammals in South America were unlike placentals anywhere else. They included ground sloths as big as elephants as well as armadillos covered by bony plates like suits of armour. Late in the Cenozoic Era, South America and North America became connected by a land bridge. South American placentals then wandered across this Central American bridge to North America. The opossum also made its way from South America and became the only North American marsupial. Most marsupials in South America died out after meat-eating placentals from North America migrated across the land bridge.

### The study of prehistoric animals

Scientists called *palaeontologists* learn about prehistoric animals by examining fossils. The science of prehistoric life is called *palaeontology*. Fossils provide a record of past plant and animal life on the earth. They also help scientists reconstruct the environments in which prehistoric animals lived.



Field Museum of Natural History, Chicago

**A flying reptile,** *rhamphorhynchus,* left this fossil in limestone. The fossil shows the animal's long bony tail, toothed jaws, and the membranes of skin that formed its wings.

**Interpreting fossil evidence.** Rarely was an entire prehistoric animal preserved as a fossil. Most animal fossils consist of bones, teeth, or shells, which decay less rapidly than skin, muscles, and other soft parts. But from only part of a prehistoric animal, palaeontologists can learn much about the animal.

Palaeontologists reach conclusions about prehistoric animals by comparing fossils with living animals. For example, they estimate a fossil animal's size and shape by comparing its bones to similar bones of related living animals. Such comparisons can also indicate how prehistoric animals lived. From studying modern animals, palaeontologists know that a prehistoric animal with long leg bones could run quickly. An animal that had short, strong leg bones probably dug out food from the ground. Sharp teeth indicate a meat-eating animal. An animal with blunt teeth probably ate plants.

Animals called *living fossils* also provide clues to the structure and behaviour of prehistoric animals. Living fossils are surviving species of creatures that lived in prehistoric times. An example of a living fossil is the *coelacanth*, a kind of lobe-finned fish that lives off the southeast coast of Africa. Coelacanths have changed little since prehistoric times.

Some groups of prehistoric animals left behind more distant descendants. Birds are the closest living relatives of dinosaurs. Birds more closely resemble dinosaurs in bone structure than do any other living animals.

**Evolution and extinction.** The study of prehistoric animals provides evidence to support the *theory of evolution.* This theory states that all living things gradually developed from simpler organisms. The theory further states that organisms change in response to changes in their environment—that is, they develop specialized characteristics that increase their chances of adapting to the new conditions.

As new prehistoric animals evolved, others became extinct. Mass extinctions occurred during several periods. Large amphibians died out at the end of the Triassic Period. Dinosaurs and other giant reptiles disappeared at the end of the Mesozoic Era. Many large Ice Age mammals such as the mammoths, vanished about 10,000 years ago.

The question of why prehistoric animals became extinct has produced much debate. Some scientists believe that an extraordinary event, such as the collision of an asteroid with the earth, caused the mass extinctions. But other scientists point out that such a theory does not explain why only some animals died out at any one time. These scientists suggest that the cause of extinction may have been different for each group of animals. For example, the climate may have become too cold for a group. A group may have been unable to compete successfully with other animals for food. Or a group may have been killed off by disease. In any case, animals that could not adapt to new environmental conditions died out. Most species of animals that have ever lived on the earth are now extinct.

**Related articles** in *World Book* include:

**Prehistoric animals**

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Coelacanth
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Trilobite

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Horse (Origins of the horse)
Ice Age
Mammal (The evolution of mammals)
Palaeontology
Plant (Early plants)
Pleistocene epoch
Prehistoric people
Reptile (The evolution of reptiles)

**Outline**

**I. The world of prehistoric animals**
**II. Early forms of animal life**
A. The first animals
B. Animals with backbones
C. The move onto land
**III. The Age of Reptiles**
A. Dinosaurs
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C. Invertebrates
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**IV. The Age of Mammals**
A. The development of placentals
B. The distribution of mammals
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B. Evolution and extinction

**Questions**

Which prehistoric animals became the ancestors of the first vertebrates to live on land?
Why did a wide variety of marsupials develop in Australia and South America?
Why did prehistoric birds leave few fossils?
What were some giant reptiles besides dinosaurs that lived during the Mesozoic Era?
How do scientists know what prehistoric animals looked like and when, where, and how they lived?
What conditions helped mammals develop rapidly early in the Cenozoic Era?
Why is the Devonian Period called the *Age of Fishes*?
From what prehistoric animals did birds evolve?
What are *living fossils*?
How big were the first horse and camel?

**Prehistoric people** are the ancestors of modern human beings. This illustration is an artist's idea of how one type of prehistoric people, *Homo erectus,* may have learned to use fire. Cultural advances, such as the use of fire and clothing, helped *Homo erectus* spread to much of the world.

# Prehistoric people

**Prehistoric people** are human beings who lived before writing was invented about 5,500 years ago. Writing enabled people to record information they wished to save, including descriptions of events in their lives. In this way, the invention of writing marked the beginning of history. The period before human beings learned to write is called *prehistory,* and people who lived during this period are known as *prehistoric people.*

Most scientists believe the first human beings lived about 2 million years ago. But early humans probably arose from ancestors who first lived more than 4 million years ago. These prehuman ancestors were small, humanlike creatures who walked erect. This article will discuss both prehistoric people and their near ancestors.

Scientists first discovered evidence of prehistoric people during the mid-1800's. Most of this evidence consisted of ancient, sharp-edged tools that prehistoric people had made of stone. The first fossilized bones of prehistoric people were also found during this time.

As scientists collected more fossils of prehistoric people, they began to form a clearer picture of what these early people looked like. For example, fossil evidence showed that early human beings had smaller brains than most modern people have. This indicated to many scientists that humans had *evolved*—that is, modified their physical structure over time. Scientists developed a set of ideas about human origins called the theory of human evolution. This theory states that as the environment of the world changed, the prehuman ancestors of prehistoric people went through a series of changes that resulted in the first human beings. They, in turn, evolved into modern human beings.

Today, many kinds of scientists work together to learn about prehistoric people. Archaeologists search for and examine such physical evidence as pottery and tools to help explain how prehistoric people lived. Botanists study the remains of prehistoric plants, and zoologists analyse fossils of prehistoric animals that lived during the time of prehistoric people. Geologists study the layers of rock in which fossils are found. All these scientists are called *anthropologists* if their chief concern is the study of human physical and cultural development.

Evidence of prehistoric people—such as fossils, tools, and other remains—is rare and often fragmented. Evidence of the earliest types of prehistoric people is the most difficult to find. Anthropologists must base their theories about prehistoric people's way of life on this extremely limited evidence. As a result, scientists cannot yet present a detailed picture of early human life. In addition, new discoveries sometimes disprove theories that scientists already hold.

## Prehuman ancestors

Most scientists believe that human beings and apes—such as chimpanzees and gorillas—share a common ancestor. To support this theory, scientists point out that the fossilized remains of ancient humanlike beings and apes reveal many similarities, including similar brain sizes. In addition, studies comparing the physical structure, blood, and genetic material of modern humans with those of apes show that people are more similar to apes than to any other living animal.

The ancestors of human beings probably began evolving separately from the ancestors of apes between about 10 million and 5 million years ago. This evolutionary split marks the beginning of the development of *hominids.* Hominids are members of the scientific family made up of human beings and early humanlike ancestors. Most anthropologists believe the first hominids were humanlike creatures called *australopithecines.*

**Where and when they lived.** The australopithecines first appeared more than 4 million years ago in Africa. Fossil evidence suggests that these creatures became extinct between 2 million and 1 million years ago, about when the first human beings appeared.

Scientists have discovered australopithecine fossils at sites in eastern and southern Africa. Because these are the oldest examples of hominid fossils, most scientists generally believe that the hominid family originated in Africa and prehistoric people later spread out into other parts of the world.

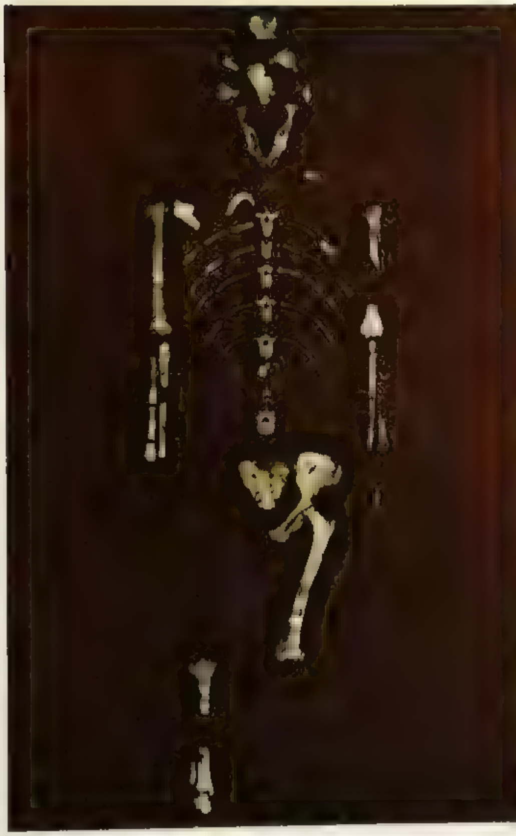
**What they looked like.** The australopithecines looked very different from modern human beings. In some ways, such as in their facial features, they may have resembled chimpanzees. However, many, if not all, australopithecine species could stand upright and walk on two legs, and their canine teeth were much smaller and less pointed than those of apes. These features identify australopithecines as members of the hominid family and separate them from the ape family.

The australopithecines had large faces that jutted out. Their brains were about one-third the size of modern human brains. Their molars were large, flat, and suitable for grinding food. Anthropologists believe from the shape of these creatures' teeth that they ate such foods as fruit, vegetables, nuts, seeds, and insects.

**Types of australopithecines.** The australopithecines were members of the genus *Australopithecus* (southern ape). According to differences in the shape of the creatures' jaws and teeth and the size of their brains, scientists have divided the genus *Australopithecus* into five species: (1) *A. ramidus,* (2) *A. afarensis,* (3) *A. africanus,* (4) *A. robustus,* and (5) *A. boisei.*

The earliest species of *Australopithecus* was *A. ramidus,* which appeared in eastern Africa about 4.5 million years ago. Not much is known about this creature. But some of its teeth resemble those of chimpanzees, suggesting that *A. ramidus* may have lived at about the time when the human and ape lines separated.

The next species of *Australopithecus* was *A. afarensis,* which appeared about $3\frac{3}{4}$ million years ago. The most complete australopithecine fossil scientists have found is a partial skeleton of a female *A. afarensis.* It was found in Ethiopia. This creature, nicknamed "Lucy," was probably more than 110 centimetres tall and weighed about 30 kilograms. *A. afarensis* had about the same size brain that a chimpanzee has.



**The skeleton of "Lucy,"** a prehuman ancestor, is the most complete australopithecine fossil that scientists have found. This creature lived about $3\frac{1}{4}$ million years ago.

By about $2\frac{1}{2}$ million years ago, *A. africanus* replaced *A. afarensis.* Scientists have found fossils of *A. africanus* at several sites in South Africa. These creatures had rounder skulls and slightly larger brains than those of *A. afarensis,* but in other features they were not much different.

Many scientists believe that an evolutionary split occurred among the australopithecines during the time of *A. africanus.* This split resulted in the appearance of an additional evolutionary line, separate from *A. africanus,* that led to *A. robustus* and *A. boisei.* Scientists refer to these two species as the *robust* australopithecines. They had larger molars and more powerful jaws than the other two species of *Australopithecus.* But their brain size was about the same as that of *A. africanus.* The earlier two species are called *gracile* (slender) australopithecines. The robust australopithecines probably became extinct about 1 million years ago.

## The first human beings

Most anthropologists believe that the first human beings evolved from a gracile australopithecine about 2 million years ago. The oldest tools that scientists have found date from about $2\frac{1}{2}$ million years ago. But be-

cause no hominid fossils were found with these tools, scientists do not know whether an australopithecine or an early human made them.

Most prehistoric tools that have been found and studied are made of stone. As a result, this period of time is called the Stone Age. Early toolmakers may also have used wood and other materials, but none of those tools have survived. The Stone Age lasted from the first use of stone tools until bronze replaced stone as the chief toolmaking material. In some areas, this occurred about 3000 B.C. The first part of the Stone Age is called the Palaeolithic Period. This period lasted until about 8000 B.C., after people had started farming. Even after some people learned to provide food by farming, many others continued to live by gathering wild plants and by hunting. These Stone Age hunters and gatherers who lived after 8000 B.C. are called Mesolithic people. Farmers from this period are called Neolithic people.

***Homo habilis*** is considered by anthropologists to be the oldest human species. These prehistoric people lived in Africa about 2 million years ago. The Latin word *homo* means *human being. Habilis* means *handy* or *skilful.* Anthropologists have found important fossils of *Homo habilis* at sites east of Lake Turkana in northern Kenya and in Olduvai Gorge in Tanzania.

*Homo habilis'* brain was much larger than that of an australopithecine, but only about half the size of a modern human brain. *Homo habilis* also had smaller molars and a less protruding face than the australopithecines had. Some fossil evidence indicates that *Homo habilis*

**Footprints of a prehuman ancestor** were found at Laetoli, in Tanzania. These footprints, which were fossilized in volcanic ash, provide evidence that early hominids walked upright.

males were much larger than *Homo habilis* females. This difference, known as *sexual dimorphism,* appears among many modern primates. Scientists have also detected such a difference among the australopithecines. Among modern human beings, however, sexual dimorphism is less extreme.

Many anthropologists believe *Homo habilis* made the first tools. Some of the earliest known tools have been found with *Homo habilis* fossils. These devices were sharp-edged stones used for cutting, scraping, and chopping. Prehistoric people made them by striking one piece of stone with another, chipping pieces away to produce a cutting edge. These first tools were extremely crude, but over time early human beings began to craft tools of a finer quality. Later toolmakers started using mallets of wood or bone to tap away small chips of stone, producing a straight, sharp cutting edge.

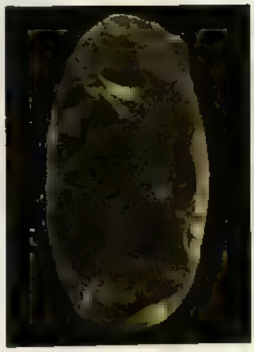
Scientists believe *Homo habilis* ate meat in addition to fruit, insects, and plants. Archaeologists have found animal bones buried with stone tools from the time of *Homo habilis.* Many of the bones show scratch marks that were probably made by the cutting action of stone tools. These marks indicate that *Homo habilis* used tools to butcher game and to scrape meat off bones. But scientists do not know whether these early humans killed large animals themselves or merely ate the meat after the animals had been killed by predators.

***Homo erectus.*** Fossil evidence indicates that by about $1\frac{1}{2}$ million years ago, *Homo habilis* had evolved into a more advanced human species. Scientists call this species *Homo erectus.* The term *Homo erectus* refers to the upright posture of these creatures. One of the best examples of *Homo erectus* that scientists have found is a nearly complete fossil skeleton of a boy who was probably about 12 years old. The skeleton, which is more than $1\frac{1}{2}$ million years old, was found west of Lake Turkana in northern Kenya.

*Homo erectus* probably stood slightly more than 150 centimetres tall. These creatures had thick skulls, sloping foreheads, and large, chinless jaws. Their skulls had a *browridge,* a raised strip of bone across the lower forehead. *Homo erectus* also had smaller molars, a smaller face, and a less protruding face than *Homo habilis* had. The brain size of early *Homo erectus* was only slightly larger than that of *Homo habilis.* During the course of *Homo erectus* evolution, however, brain size increased considerably. It eventually reached a size just slightly smaller than that of a modern human brain. Fossil evidence indicates that *Homo erectus* males were larger than *Homo erectus* females.

The earliest *Homo erectus* fossils have been found in Africa, where these prehistoric people probably remained until about 1 million years ago. Many scientists believe that prehistoric people had begun to migrate out of Africa by that time. Anthropologists have found fossil bones of *Homo erectus* that date from about 1 million years ago on the island of Java, in Indonesia. *Homo erectus* tools from the same time have been discovered in southern Europe and Asia. By about 500,000 years ago, *Homo erectus* had spread into northern Asia.

*Homo erectus* was probably the first human being to master the use of fire. These people may also have been the first to wear clothing. Scientists believe that as *Homo erectus* moved into northern areas and faced



**Prehistoric tools**

**Prehistoric tools** were made chiefly of stone. Neanderthals made a variety of tools, including the hand axe, *top left,* and the scraper, *bottom left.* To form these tools, they used a hard object—such as a rock or bone—to chip pieces away from a carefully selected stone. Later prehistoric people used more complicated toolmaking techniques, such as the one shown on the far left. This process, employed by Upper Palaeolithic people, required the cooperation of two individuals. The toolmakers used two hard objects as a hammer and chisel to split bladelike slivers from a large stone. In this way, they could make many useful tools from a single stone.

cold winters, fire and clothing became necessary. Archaeologists have not found any traces of early clothing, but it was probably made from animal hides. The oldest evidence of the use of fire was found in a cave that *Homo erectus* occupied about 500,000 years ago near what is now Beijing, in northern China. Stone tools and the remains of more than 40 *Homo erectus* individuals were found in the cave, along with burnt animal bones surrounded by thin layers of ash.

*Homo erectus* was a more skilful toolmaker than *Homo habilis.* For example, *Homo erectus* created double-edged cutting tools called *hand axes* out of stone. These early human beings probably used hand axes for many tasks, such as shaping wood or bone and cutting up meat. The bones of large animals, including mammoths, have been found at *Homo erectus* sites. But scientists do not know if these people actually hunted big game. They may have collected the remains of animals that had been killed by predators. The main foods in the *Homo erectus* diet were probably fruit, vegetables, nuts, seeds, insects, and small animals.

### Early *Homo sapiens*

Between about 400,000 and 300,000 years ago, *Homo erectus* evolved into a new human species called *Homo sapiens.* Because evolution took place gradually during this time, anthropologists have found it difficult to say precisely when *Homo sapiens* first appeared. Anthropologists disagree on whether certain fossil specimens from this period are *Homo sapiens* or *Homo erectus.*

The term *Homo sapiens* means *wise human being.* All people living today belong to this species. But early *Homo sapiens* differed greatly from modern people.

**The first *Homo sapiens*** strongly resembled *Homo erectus.* The main difference between the two was that *Homo sapiens* had a higher and more rounded skull. However, like *Homo erectus,* the first *Homo sapiens* individuals had large faces that protruded around the mouth and nose. They also had big browridges and low, sloping foreheads. These people lacked a chin, a feature found only in the modern type of human beings.

The brain size of early *Homo sapiens* varied over a wide range. Some of these people had brains that were similar in size to those of late *Homo erectus.* Others had brains nearly as large as modern human brains.

Early *Homo sapiens* were about as tall as modern human beings. They were solidly built with powerful muscles and were probably much stronger than modern people. The differences in size between males and females that is so well marked in earlier hominids appears to be reduced in *Homo sapiens.*

*Homo sapiens* were the first prehistoric people to inhabit large areas of Europe. Anthropologists have found important *Homo sapiens* fossils in England, France, Germany, Greece, and Italy. *Homo sapiens* fossils have also been discovered in many parts of Asia and Africa.

Some of the most important evidence of *Homo sapiens'* way of life comes from a site called Terra Amata, which lies near Nice, France, along the coast of the Mediterranean Sea. Terra Amata was a settlement occupied by what some anthropologists believe was a group of *Homo sapiens* about 250,000 years ago or earlier.

At Terra Amata, scientists found evidence of tentlike structures that a group of *Homo sapiens* probably built for shelter. Further evidence indicates that this group stayed for periods of time at Terra Amata to hunt and gather food during a yearly round of various campsites. Prehistoric people did not form permanent settlements

## The development of prehistoric human beings

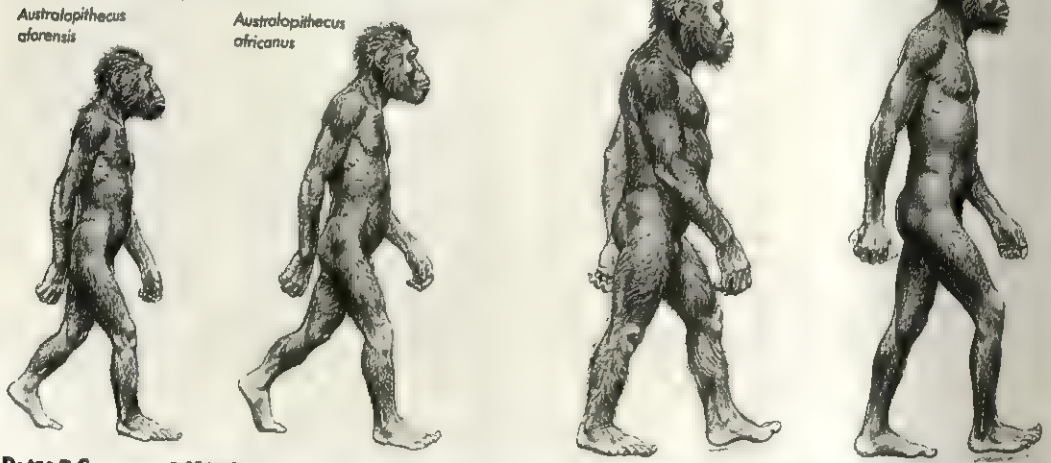
**The skulls of prehistoric people** changed dramatically over time. By studying the fossilized skulls of our prehuman and early human ancestors, scientists have gained valuable information about these creatures.

***Australopithecus africanus***
Transvaal Museum, Pretoria, South Africa

***Homo habilis***
National Museums of Kenya, Nairobi

***Homo erectus***
National Museums of Kenya, Nairobi

**The evolution of human beings** took place gradually over millions of years. The illustrations below are an artist's impression of how some of the major species of prehuman and early human ancestors may have looked.




**Dates B.C.**

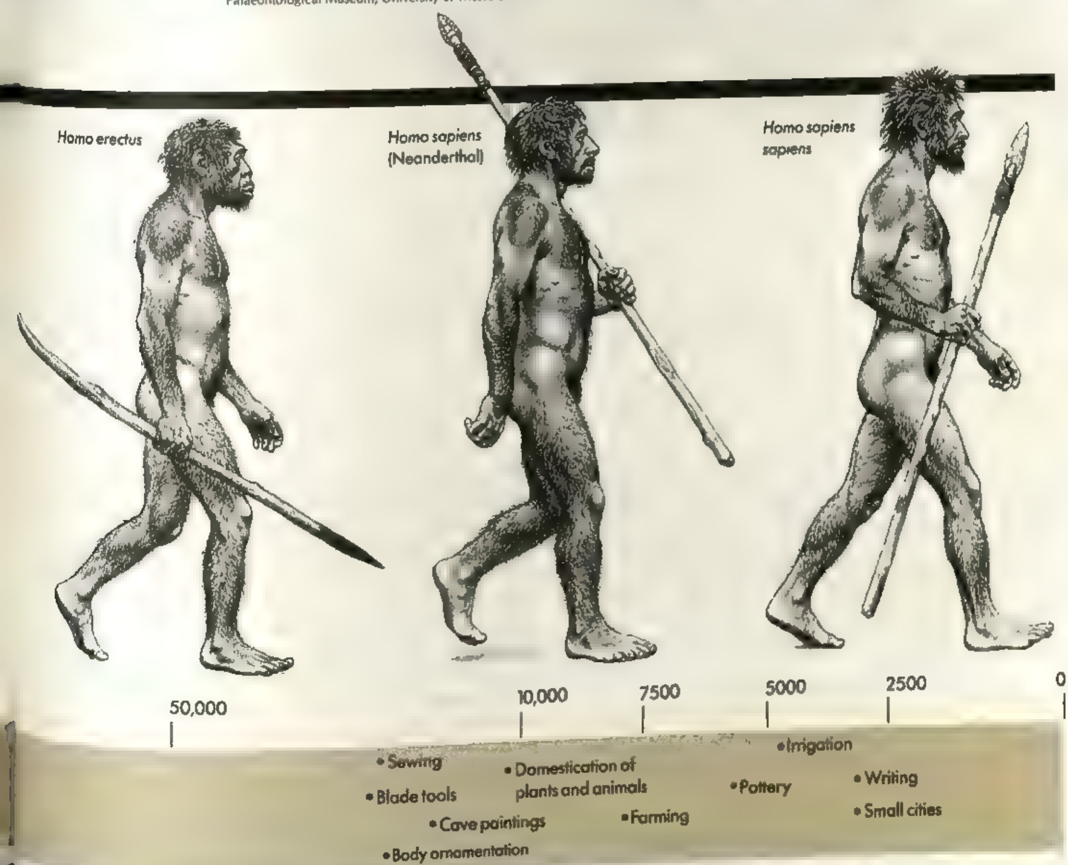
3,000,000 | 2,000,000 | 1,000,000 | 750,000 | 500,000 | 250,000 | 100,000

**Cultural developments**

- Pebble tools
- Hand axes
- Ability to make fire
- Chopping tools
- Burial of the dead

**Homo sapiens (early)**
Palaeontological Museum, University of Thessaloniki

**Homo sapiens sapiens**
Musee de l'Homme, Paris



**A Neanderthal grave** from Kebara Cave in Israel contains a human skeleton that is about 60,000 years old. Such graves suggest that the Neanderthals were the first to bury their dead.

until farming began about 11,000 years ago. But the studies at Terra Amata suggest that earlier people created temporary settlements at specific locations based on their knowledge of food sources.

**Neanderthals** were a type of early *Homo sapiens* who lived in parts of Europe and the Middle East from about 130,000 to 35,000 years ago. Different types of early *Homo sapiens* occupied other parts of Africa, Europe, and Asia during this period. Neanderthals have become the most widely known of the early *Homo sapiens* mainly because they were the first prehistoric people to be discovered. The term *Neanderthal,* also spelled *Neandertal,* comes from the Neander Valley near Düsseldorf, Germany. The first Neanderthal fossils that scientists identified as prehistoric people were found there in 1856.

The Neanderthals were large and muscular. Like other early *Homo sapiens,* they had protruding faces, large browridges, and low foreheads. Most of them also lacked a chin. However, the Neanderthals had large brains. Their average brain size was larger than that of modern human beings.

Some Neanderthals lived in Europe during the Ice Age, when sheets of ice covered many northern parts of the world. These Neanderthals developed qualities that enabled them to cope with harsh winter conditions. Archaeologists have found most evidence of Neanderthals in caves, where many of these people lived to escape the extreme cold. But archaeologists have also discovered sites where Neanderthals camped in the open. These sites provide evidence that the Neanderthals pitched large circular tents around a central hearth area. The tent covering probably consisted of hides, leaves, or bark supported by wooden posts and secured to the ground by stakes made from animal bones.

The Neanderthals were more skilled hunters and toolmakers than earlier prehistoric people. The bones of many animals have been found at Neanderthal sites. Some of the bones indicate these people sometimes hunted such large animals as horses, reindeer, and mammoths. But they were more successful in capturing hares and other small animals. The Neanderthals made a variety of stone tools. They used these tools to butcher animals, prepare vegetable foods, scrape animal hides, and carve wood. They also made sharp, pointed tools that may have been spearheads.

The Neanderthals were the first human beings known to have buried their dead. In Neanderthal sites throughout Europe and the Middle East, archaeologists have uncovered the carefully buried skeletons of women, men, and children. Anthropologists do not understand why the Neanderthals adopted this custom.

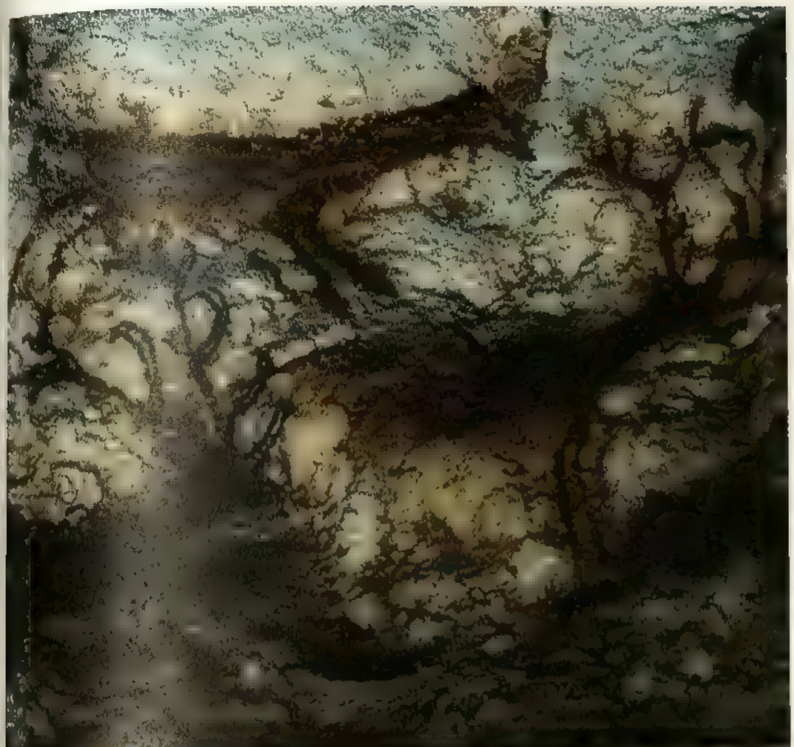
### The rise of modern human beings

The first prehistoric people with modern human features appeared about 100,000 years ago in either the Middle East or Africa. These people had a chin, a high forehead, and a smaller, less-protruding face than earlier *Homo sapiens* had. The first physically modern human beings also lacked the large browridge of earlier people and had a higher and more rounded skull. Scientists classify modern human beings as *Homo sapiens sapiens,* a subspecies of *Homo sapiens.*

Anthropologists are fairly certain that the first modern human beings evolved from earlier types of *Homo sapiens.* But scientists have had difficulty understanding the precise evolutionary relationship between modern humans and early *Homo sapiens.* For example, fossil evidence shows that Neanderthals lived in Europe and the Middle East after the modern type of human beings appeared. This evidence makes it difficult for scientists to determine whether Neanderthals were the ancestors of modern Europeans or were a related type of early human being that became extinct.

The question of human races is related to the origin of modern human beings. Most anthropologists today reject the idea that the human population can be divided into biologically defined races. Physical features of modern human beings change gradually from one region to another, making it difficult to draw a dividing line between them. However, anthropologists have observed that groups of people who have lived in certain parts of the world for many thousands of years tend to differ in appearance from groups in other parts of the world. These differences are probably adaptations to local environments. For example, people whose ancestors have lived for generations in sunny climates tend to have dark skin. Dark pigment helps protect the skin from sunburn and reduces the risk of skin cancer.

Anthropologists have developed two main theories to



**Cave paintings** were some of the earliest works of art. The development of art began during the Upper Palaeolithic, a period beginning about 35,000 years ago. Many cave paintings of deer, *left,* were found at Lascaux, a cave in southwestern France. The handprints of prehistoric people, *above,* decorate the walls of Gargas Cave in southern France. These prints show that some of the prehistoric artists had lost parts of their fingers.

explain the origin of modern human beings and the development of what are sometimes called "races"—that is, the physical differences among populations in different regions. These theories may be referred to as (1) the multiple origins theory and (2) the single origin theory.

**The multiple origins theory.** Some anthropologists believe that the spread of separate human populations began with the migration of *Homo erectus* out of Africa about 1 million years ago. According to this theory, *Homo erectus* split into separate populations in Africa, Asia, and Europe. These groups evolved according to their different environments and developed different physical characteristics. Eventually, *Homo erectus* in each geographic area evolved into a form of *Homo sapiens* unique to the area. These multiple types of *Homo sapiens,* in turn, became the ancestors of the so-called modern human races.

The best evidence supporting this theory comes from a series of skulls found in Indonesia and Australia. In age, these skulls span a period beginning about 1 million years ago and lasting until the appearance of physically modern human beings. All the skulls show similar features that are characteristic of that part of the world. These fossils appear to represent a population that continuously evolved over time and resulted in modern Southeast Asian people.

**The single origin theory.** Other anthropologists disagree with the multiple origins theory and claim that separate modern human populations had a common ancestor much more recently. According to this single origin theory, modern human beings—*Homo sapiens sapiens*—first appeared in either Africa or the Middle East between 200,000 and 100,000 years ago. This modern type of human being then spread to other parts of Africa, Asia, and Europe, replacing the older populations of *Homo sapiens* who were living there. All other populations of early human beings, such as Neanderthals, became extinct. According to this theory, the development of different physical characteristics in today's so-called racial groups began with the spread of *Homo sapiens sapiens* from Africa or the Middle East.

Some of the best fossil evidence that supports this theory comes from cave sites in Israel. At two of these sites, called Qafzeh and Skhul, archaeologists excavated fossil skeletons of modern-looking human beings that date from about 100,000 years ago. But at a nearby site called Kebara, a Neanderthal skeleton that dates from about 60,000 years ago was found. Supporters of the single origin theory point out that it is difficult to place the Neanderthals as ancestors of modern human beings if they were known to have lived after modern human beings first appeared. Therefore, another group—the first modern humans from either Africa or the Middle East—must have replaced the Neanderthals.

Some scientists also support this theory through use of genetic evidence from living people. Molecular biologists have gained a greater understanding of human evolution by studying the rate of change of human genetic material. By calculating this rate of change, some scientists have concluded that all living human beings must have evolved from one physically modern human ancestor who lived about 200,000 years ago. In one version of this theory, the common ancestor—who has become known as African Eve—was a Stone Age woman in Africa. Although most scientists accept the conclusion of genetic studies that modern human beings originated

in Africa, many of them believe this common ancestor appeared earlier than supporters of the single origin theory claim.

### Cultural development of modern human beings

Fossil evidence indicates that the cultural activities of the first physically modern humans were similar to those of other *Homo sapiens* who lived during that time. For example, the modern-looking human beings from the 100,000-year-old sites of Qafzeh and Skhul were found with the same kinds of stone tools that Neanderthals used at sites nearby. Thus, the appearance of modern human beings did not represent a sudden change in life style or culture from the earlier populations.

Throughout the early stages of human evolution, the rate of cultural change among prehistoric people was extremely slow. Stone tools and other products of human skill remained unchanged for many thousands of years. However, about 35,000 years ago, the rate of cultural change began to accelerate rapidly. This later period is generally referred to as the Upper Palaeolithic.

During the Upper Palaeolithic, prehistoric people made an extraordinary number of advances in their way of life. The best-known type of human beings from this period are the Cro-Magnons. The Cro-Magnons lived in Europe, the Middle East, and North Africa from about 40,000 to 10,000 years ago. Scientists believe they resembled modern Europeans.

**The improvement of tools** was one of the major accomplishments of the Cro-Magnons and other Upper Palaeolithic people. After 35,000 years ago, new tool types and methods of manufacture appeared at a rapid pace. Stone tools made during this time were much more refined and complex in design. Toolmakers invented many new devices to serve specialized carving, cutting, and drilling functions. Tools made from bone, ivory, and animal horns also became widely used. Archaeologists have found harpoons, fish spears, and needles made from bone that date from this period. These tools suggest the introduction of many new activities, such as sewing close-fitting clothes and fishing with improved equipment.

Upper Palaeolithic fossil sites also indicate that these people had become skilful hunters. Some sites hold the remains of thousands of animals. In addition, the bones of mammoths, horses, and reindeer are common, suggesting these people hunted large animals successfully.

**The appearance of art** was one of the most spectacular developments of the Upper Palaeolithic. The oldest works of art that archaeologists have found date from this period. Furthermore, the practice of creating art seems to have spread rapidly—especially in Europe.

Some of the oldest artworks from the Upper Palaeolithic were ornaments, such as beads made from polished shells. After about 20,000 years ago, prehistoric people began to produce a variety of artwork. They excelled at carving—creating beautiful sculptures of animals and people, usually from ivory or bone. They also made engravings of people, fish, birds, and other animals on bone, ivory, and stone. The Upper Palaeolithic people also sculpted clay, ivory, and stone figurines of women, which may have represented fertility.

A number of caves in Europe are covered with paintings, drawings, and engravings from the Upper Palaeolithic. Most distinctive of these are the paintings, which appear on the cave walls and ceilings. Most of the paintings are of the animals early people probably hunted, including bison, mammoths, and horses. Some of the paintings show animals that have been speared.

Many of the paintings are of a high artistic quality. Palaeolithic artists used three basic colours: black, red, and yellow. They obtained these pigments from natural sources including charcoal, clay, and such minerals as iron. Often, the artists painted animals on a part of the cave wall where there was a natural swelling, which created a three-dimensional effect.

**The development of speech.** No one knows when or how spoken language developed. However, many anthropologists think that human beings may have first begun to speak sometime during the Upper Palaeolithic. These scientists believe that the many cultural developments which occurred at this time—especially the appearance of art—may be related to the development of speech. The beginnings of speech, the creation of artwork, and the making of complex tools all required advancements in human intelligence and cooperation.

**The spread of settlement.** Prehistoric people spread into new areas during the Upper Palaeolithic. Cultural and technological advances enabled them to migrate to such places as Australia, the Pacific Islands, and North and South America.

Perhaps as early as 50,000 years ago, people used boats to reach Australia. About 20,000 years ago, people from Australia and Asia began to colonize the Pacific Islands. These people employed sophisticated navigational systems that involved knowledge of the stars, water currents, and wind direction. They also used simple navigational instruments.

By 30,000 years ago, human beings had spread to the cold, harsh tundra of northeast Asia. At that time, the Bering Strait was a land bridge that connected Asia and North America. Most scientists believe that prehistoric people crossed this land bridge and were living in North America by 15,000 years ago. Eventually, early modern human beings populated all of North and South America.

The last Ice Age ended about 10,000 years ago. As the vast sheets of ice receded, the environment of many prehistoric people changed and greatly affected their way of life. In some areas, such as Europe, forests began to spread across the land. The people of these areas learned to hunt new species of animals and gather new varieties of plants from these forests. In other parts of the world, people began to experiment with methods of controlling their supply of food. This led to the beginning of farming.

**The rise of agriculture,** according to most scientists, began in the Middle East about 11,000 years ago, or 9000 B.C. The first farmers lived in a region called the Fertile Crescent, which covers what is now Lebanon and parts of Iran, Iraq, Israel, Jordan, Syria, and Turkey. At first, these people probably did not depend entirely on the crops they grew. But as they improved their methods, farming became their most important source of food. The earliest plants grown in the Middle East were probably barley and wheat. Early farmers in the Middle East eventually reared cattle, goats, pigs, and sheep.

The first farmers originated in areas where there

## Important fossils of prehistoric people

| Fossil | Location | Date found | Discovered or identified by | Importance |
|---|---|---|---|---|
| | | ***Australopithecus*** | | |
| Taung child | Taung, near Vryburg, South Africa | 1924 | Raymond Dart (South African) | First australopithecine discovered |
| Kromdraai hominid (formerly *Paranthropus robustus*) | Kromdraai, in the Sterkfontein Valley near Johannesburg, South Africa | 1938 | Robert Broom (South African) | First *A. robustus* discovered |
| OH 5, nicknamed "Zinj" (formerly *Zinjanthropus boisei*) | Olduvai Gorge, Tanzania | 1959 | Mary Leakey (British) | First East African australopithecine found |
| "Lucy" | Hadar, Awash River Valley, Ethiopia | 1974 | Donald Johanson (U.S.) | Most complete australopithecine skeleton |
| Laetoli fossil footprints | Laetoli, near Lake Eyasi, Tanzania | 1978 | Mary Leakey (British) | Evidence that australopithecines walked erect |
| | | ***Homo habilis*** | | |
| Olduvai Gorge *Homo habilis* | Olduvai Gorge, Tanzania | 1960 | Jonathan Leakey (Kenyan) | First *H. habilis* found |
| ER-1470 | Lake Turkana (formerly Lake Rudolf), Kenya | 1972 | Richard Leakey (Kenyan) | Oldest known *H. habilis* skull |
| | | ***Homo erectus*** | | |
| Java fossils (formerly *Pithecanthropus erectus*) | Trinil, Indonesia, on the Solo River, island of Java | 1891 | Eugène Dubois (Dutch) | First *H. erectus* found |
| Peking fossils | Zhoukoudian, near Beijing | 1921-1937; 1949-1966 | Davidson Black (Canadian) | Largest collection of *H. erectus* fossils found |
| East Turkana *Homo erectus* | Lake Turkana, Kenya | 1975 | Richard Leakey (Kenyan) | Earliest African *H. erectus* found, dating from about 1,800,000 years ago |
| Nariokotome boy | Lake Turkana, Kenya | 1984 | Kamoya Kimeu (Kenyan) | Skeleton of a boy, the most complete *H. erectus* found |
| | | ***Homo sapiens*** | | |
| Kabwe fossil (formerly Rhodesian man) | Kabwe (also known as Broken Hill), Zambia | 1921 | Arthur Smith Woodward (British) | Early African *H. sapiens* |
| Dali skull | Dali, Shanxi Province, China | 1978 | Wu Xinzhi (Chinese) | Early Asian *H. sapiens* |
| Neanderthal | Neander Valley, near Düsseldorf, Germany | 1856 | Johann Fuhlrott (German) | First fossil recognized as remains of prehistoric people |
| "Old Man" of La Chapelle-aux-Saints | La Chapelle-aux-Saints, near Brive, France | 1908 | Amédée Bouyssonie and Jean Bouyssonie (French) | Most complete Neanderthal skeleton |
| Skhul skeletons | Skhul Cave, Mount Carmel, Israel | 1931-1932 | Theodore McCown and Hallam Movius (U.S.) | Early modern humans (*H. sapiens sapiens*), dating from 100,000 years ago |
| Qafzeh skeletons | Qafzeh Cave, near the Sea of Galilee, Israel | 1933-1975 | René Neuville and Bernard Vandermeersch (French) | Early *H. sapiens sapiens*, dating from 100,000 years ago |
| Cro-Magnons | Les Eyzies, near Brive, France | 1868 | Louis Lartet (French) | First Cro-Magnon skeletons discovered |

## Where remains of prehistoric people have been found

The earliest fossils and other remains of prehistoric people have been found in Africa, Asia, and Europe. Most scientists believe that our closest prehuman ancestors originated in Africa, and prehistoric people later spread to other parts of the world.


- ● Australopithecus
- ■ Homo habilis
- ◆ Homo erectus
- ▲ Homo sapiens

were enough wild plants and animals to provide food for large populations. As a result, people often settled in permanent villages for years at a time. At the end of the Ice Age, the climate became warmer and affected the food supply. New plants, such as grains, replaced older plants. Scientists believe that Upper Palaeolithic people were able to remain in permanent settlements because they discovered how to control these new plants and increase the amount of food in their area. They learned that they could plant seeds from the plants that they ate. They also learned that they could domesticate animals, perhaps by capturing young ones from the wild and rearing them. In time, people began to depend on these planted crops and domestic animals for a steady supply of food.

By about 7000 B.C., agriculture had developed independently in Asia and southern North America. In what are now Thailand and southern China, farmers grew breadfruit, bananas, and rice, while people in what became Mexico grew beans, maize, and vegetable marrows.

People were herding cattle and growing grain in northern Africa by 6000 B.C. By that time, people had also begun to farm in the Indus River Valley of what is now Pakistan. By 4000 B.C., farming had begun in the Huang He Valley of China. Farming spread throughout most of Europe by 3000 B.C. Farming in most parts of North and South America began after prehistoric times. Food was probably more plentiful in these areas, so farming did not become necessary until later.

**Changes in life style.** Prehistoric farmers, called *Neolithic* people, had a way of life that differed greatly from that of Upper Palaeolithic people. In some ways, farming made life easier. It provided a steady supply of food and enabled people to stay in one place for a long time. However, farmers also had to work longer and harder than did hunters and gatherers.

Prehistoric farmers set up villages near their fields and lived there as long as their crops grew well. Most fields produced good crops for only a few years. The land then became unproductive because continuous planting used up nutrients in the soil. The early farmers did not know about fertilizers that could replace these nutrients. They shifted their crops to new fields until none of the land near their village was fertile. Then they moved to a new area and built another village. In this way, farmers settled many new areas.

Prehistoric farmers built larger, longer-lasting settlements than the camps that Palaeolithic people had built. In the Middle East, for example, early farmers constructed their houses of solid, sun-dried mud. Dried mud was much more resistant to weather than the materials earlier people used, such as skins and bark. The early farmers also learned to build fences to confine and protect their livestock.

**The end of prehistoric times.** Neolithic people made inventions and discoveries at an even faster rate than did the people of the Upper Palaeolithic. Early farmers developed a number of useful tools. These implements included sickles to cut grain, millstones to grind flour, and polished stone axeheads.

By about 11,000 B.C., people had discovered how to make pottery. Before that time, they used animal skins or bark containers to hold water. To boil water, early cooks had to drop hot stones into the water, because they could not hang animal skins or bark over a fire. Pottery containers enabled people to hold and boil water easily. After the rise of agriculture, people used pottery to store grain and other food.

No one knows when people made the first objects out of metal. But metals became important only after metalworkers learned to make bronze, a substance hard and durable enough to make lasting tools. People of the Middle East made bronze as early as 3500 B.C. The Bronze Age began when bronze replaced stone as the chief toolmaking material. In some areas, such as the Near East, the Bronze Age began about 3000 B.C.

The development of farming was an important step toward the rise of civilization. As farming methods improved and food became more plentiful, many people were freed from the jobs of food production. These people developed new skills and trades. In addition, the abundant food supply enabled more people to live in each community. In time, some farming villages became cities. The first cities appeared by about 3500 B.C. These cities were the birthplaces of modern civilization.

Archaeologists believe writing was invented about 3500 B.C. in cities in the Tigris-Euphrates Valley in what is now Iraq. People then learned to record their history, and prehistoric times came to an end.

**Related articles** in *World Book* include:

| | | |
|---|---|---|
| Anthropology | Heidelberg man | Neanderthal man |
| Archaeology | Homo erectus | Peking man |
| Australopithecus | Homo habilis | Piltdown man |
| Bronze Age | Java man | Pleistocene Epoch |
| Cave dwellers | Lake dwelling | Ramapithecus |
| Cro-Magnon man | Leakey family | Stone Age |
| Evolution | Megalithic monuments | Swanscombe man |
| Fossil | | Zinjanthropus |


**Outline**

I. **Prehuman ancestors**
 A. Where and when they lived
 B. What they looked like
 C. Types of australopithecines

II. **The first human beings**
 A. *Homo habilis*
 B. *Homo erectus*

III. **Early *Homo sapiens***
 A. The first *Homo sapiens*
 B. Neanderthals

IV. **The rise of modern human beings**
 A. The multiple origins theory
 B. The single origin theory

V. **Cultural development of modern human beings**
 A. The improvement of tools
 B. The appearance of art
 C. The development of speech
 D. The spread of settlement
 E. The rise of agriculture
 F. Changes in life style
 G. The end of prehistoric times

**Questions**

When did the first human beings live?
What are *hominids*?
From what type of australopithecine did the first humans evolve?
Who were the first prehistoric people to master the use of fire?
When did scientists first find evidence of prehistoric people?
Who were the first prehistoric people to inhabit large areas of Europe?
How did early human beings make tools out of stone?
Who were the Neanderthals?
Why did some prehistoric people become farmers?

**Prejudice** is an opinion formed without taking the time or care to judge fairly. Such an opinion may be favourable or unfavourable and is held without regard to the available evidence. In this article, *prejudice* refers to an unfavourable opinion held in this way about the members of a particular social group. Prejudiced individuals tend to twist, distort, misinterpret, or even ignore facts that conflict with their predetermined opinions. For example, a prejudiced person might believe that all individuals of a certain age, national origin, ethnic group, religion, sex, or region of a country are lazy, violent, stupid, emotionally unstable, or greedy.

Because of prejudice, millions of people have been denied equal chances for jobs, housing, education, and participation in government. In Nazi Germany, extreme prejudice led to the killing of millions of Jews, Gypsies, and other members of minority groups during World War II (1939-1945).

A number of elements may contribute to prejudice. These elements include (1) competition, (2) religious ideas, (3) fear of strangers, and (4) extreme nationalism. Prejudice may develop when one group fears that competition from another group will deprive them of prestige, privilege, political power, or economic opportunities. Religious ideas—especially a lack of tolerance for religions other than one's own—have contributed to prejudice against certain ethnic and religious groups. Some people have suggested that prejudice arises from a natural fear of strangers. Extreme nationalism may cause prejudice by encouraging people to regard foreign characteristics as inferior.

Prejudice may be passed from generation to generation. Many children learn prejudice from their parents and teachers. Institutions, laws, and customs that discriminate against certain groups of people sustain prejudice. However, not all people accept the prejudices of their communities. Social scientists have learned that some people are more likely to form prejudices than other people are. This difference depends on variations in individual experiences and background.

Education, certain types of contact between groups, and institutional change may help reduce prejudice. Education helps correct false generalizations that form the basis of prejudice. Contact between groups is most likely to reduce prejudice when the groups work together for a common cause. Changes in institutions, laws, and customs to reduce discrimination might eliminate some prejudice.

See also **Anti-Semitism; Ethnic group; Ethnocentrism; Minority group; Racism; Segregation.**

**Prelate** is the title of a high-ranking church official. In the Church of England, the only prelates are bishops and archbishops. In the Roman Catholic Church, the term prelate also applies to popes, cardinals, and abbots and to other monastic officials, as well as to honorary prelates.

See also **Archbishop; Bishop; Cardinal; Pope.**

**Prelude** is a piece of music played as an introduction to other music, or before a play or an opera (see **Overture**). The first movement of a sonata or a suite may be called a prelude (see **Sonata; Suite**). In the *Preludes and Fugues* of Johann Sebastian Bach, each prelude prepares the listener for the fugue that follows. The preludes of Frédéric Chopin and later composers are more elaborate compositions. They resemble in character the pieces that pianists at one time *improvised* (made up) to begin a recital.

**Premature birth** occurs when a woman gives birth to a baby before the pregnancy reaches *full term*. This period of pregnancy ranges from 37 to 42 weeks after a woman begins her last menstrual period prior to becoming pregnant. In many cases, the exact length of a pregnancy is hard to determine. Therefore, doctors also consider any baby premature if the baby weighs less than 2,500 grams at birth.

Most premature infants that weigh more than 1,500 grams at birth grow up as healthy as babies born after a normal pregnancy. Premature babies weighing less than 1,000 grams at birth have the poorest chance of survival.

In many premature infants, certain organs—especially the lungs—have not developed sufficiently for the baby to survive without medical assistance. Respiratory distress syndrome ranks among the most serious lung disorders that strike these babies. Some infants with this condition are attached to a ventilator. Other common problems include the inability to digest normal-sized feedings and the body's lack of adequate control over its temperature. The baby may be given small amounts of milk or, if necessary, nutrients may be injected into a vein. Most premature infants are placed in an incubator to assure a constant body temperature.

Premature births occur least frequently among healthy women who receive adequate medical care. A woman can help assure a normal birth by following a well-balanced diet and by avoiding the use of tobacco, alcohol, and all drugs except those recommended by her doctor. Only 2 or 3 per cent of women who follow all of these procedures give birth prematurely. Women in low-income groups and in developing countries have much higher rates of premature births than women in high-income groups and in industrial countries.

About two-thirds of the women who give birth prematurely have a medical condition associated with premature birth. Such conditions include abnormalities of the uterus, drug addiction, high blood pressure, and being pregnant with more than one baby. A woman who has had a premature baby or a miscarriage has about a 20 per cent chance of again giving birth prematurely.

**Premenstrual syndrome (PMS)** is a condition that affects many women 3 to 10 days before the beginning of their menstrual period. The syndrome has a variety of symptoms, including anxiety, depression, sudden mood changes, crying easily, feeling angry or irritable, headaches, swelling, breast soreness, constipation, food cravings, and fatigue. Women affected by PMS may have any number of these symptoms at the same time, and the symptoms may be mild or severe.

The cause of PMS is unknown. Most doctors believe the symptoms result from hormone changes that take place during the menstrual cycle. See **Menstruation.**

Doctors distinguish PMS from other conditions by the time at which it occurs. If the symptoms occur during the few days before the menstrual period begins and at no other time, the condition is PMS.

Some women can ease symptoms of PMS by exercising regularly and by changing their diet to meet the needs of the body. Many women with severe symptoms need medication for relief. Drugs that prevent the nor-

mal hormone changes of the menstrual cycle seem to be the most effective.

**Premier** is the head of the cabinet in some countries of the world. Such a leader is known as the *prime minister* in the United Kingdom and in other countries of the Commonwealth of Nations. In many countries, the term premier means the same as prime minister. However, in Australia and Canada, the title premier is reserved for the head of the government of each province or state. The head of the national government in these countries is called the prime minister.

The office of premier developed during the 1700's, with the growth of parliamentary government in Great Britain and other European countries. At that time, the king or queen had considerable powers as head of state and appointed the premier or prime minister as head of the government.

The premier is a member of the majority political party, or one of the leading parties of the legislative body, or parliament. He or she is responsible to the parliament and to the people. A premier generally appoints the ministers who make up the cabinet. The premier and the cabinet generally resign when a majority of the members of parliament disagree with them on any important matter. A new premier is then appointed by the president or ruler of the country. The new premier is often one of the leaders of the party that opposed the old premier. Sometimes a premier may not resign when he or she is opposed, but may ask for a new parliamentary election instead. This election shows whether the people agree with the premier's policies or those of parliament. If the people support the premier, they elect a new parliament and the premier stays in office.

In some countries, the powers of the premier are less than those of other government leaders. In China, for example, where the premier is assisted by three vice-premiers, the premier is not necessarily the most powerful member of the government.

Some countries, such as the United States, have a republican form of government with an executive president. The president is head of state and head of the government. The United States government has no premier, and the president is head of the cabinet.

See also **Cabinet; Parliament; Prime minister.**

**Premiers' conference** is an annual meeting between the premiers of the six Australian states and representatives of the Australian federal government. Originally, the conferences dealt mainly with relationships between states. The premiers tried to agree on matters of common concern, such as health laws or motoring regulations. Today, the conferences are mainly concerned with the relationships between the federal government and the states, particularly how much money the federal government shall allocate to each state.

The state premiers of Australia held conferences in 1895 and 1899 in order to discuss proposals for federation. After the Commonwealth of Australia was established in 1901, they continued to meet in order to settle problems that arose from federation.

**Prendergast, Maurice Brazil** (1859-1924), was an American painter and illustrator. His paintings capture the life and movement of crowds in city parks and at the seaside. They show his familiarity with European post-impressionist experiments with form, colour, and light.

Prendergast was born in St. John's, Newfoundland, Canada, and grew up in Boston, Massachusetts, U.S.A. He was attracted by Robert Henri's philosophy of independent and spontaneous expression in art. In 1908, he exhibited with Henri's group of realistic painters called *The Eight* (later called the *Ashcan School* by critics). In 1913, Prendergast exhibited in the famous Armory Show of modern art in New York City.

See also **Ashcan School.**

**Preposition,** in grammar, is a word that introduces a word or phrase and connects that word with the word it modifies. In "The house beside the stream," *beside* is a preposition. It has an object, *stream.* The phrase as a whole acts as an adjective modifying *house.*

There are only about 60 prepositions in English. The most common ones include *at, by, in, for, on, to,* and *with.* Prepositions must have objects, the words or phrases they introduce. Thus, *down* is a preposition in the sentence "Mary fell *down* the well." *Down* has no object in the sentence "Mary fell *down*" and is an adverb.

Some prepositions express fairly clear meanings, such as time *(before, during, following, until),* or location *(against, near).* Other prepositions express meanings that are more difficult to define. They function mainly to express grammatical meanings, as in "The barking *of* the dogs kept me awake" or "This book was written *by* Mark Twain." By definition, prepositions are single words, but there are multiword phrases of the form *preposition-noun-preposition.* These phrases function as a unit *(by means of, in addition to, in spite of).*

Prepositions also are used with nouns, adjectives, and verbs in an *idiomatic* sense. This means that the combination of words assumes a special meaning. For example, we may *agree with, agree to, agree on, agree about,* or *agree among.* We may have a preference *for* something, but choose one thing in preference *to* another. We may be doubtful *of* or *about.* A woman may be impatient *with* her secretary or impatient *for* the arrival of a friend. No rules explain the differences in usage.

It used to be said that one should never end a sentence with a preposition. However, this rule is now considered old-fashioned, and never really described actual usage. Prepositions ordinarily precede their objects, but that order need not be followed. Most people recognize that "He knew what he came *for*" is a more natural expression than "He knew *for* what he came." In some instances, prepositions are unnecessary, as in "We got off *of* the ski tow." In this sentence, *of* can be omitted.

In many of the world's languages, such as Japanese, the equivalent of English prepositions come after their objects. Since these words come after rather than before their object, they are called *post*positions rather than *pre*positions.

**Pre-Raphaelite Brotherhood** was a group of seven young English artists and writers who wanted to reform England's art. They chose the name in 1848. They called themselves Pre-Raphaelites because they admired the simple, informal style of Italian painting before the work of Raphael in the early 1500's. Therefore they advocated a return to pre-Renaissance ideals of art, prizing medieval myth and literary legend in their paintings. In 1850, the group published a magazine, *The Germ,* to illustrate and spread their doctrines, but it lasted only four months.

The leading Pre-Raphaelites were William Holman Hunt, Sir John Everett Millais, and Dante Gabriel Rossetti. They were resolved to paint according to nature, not according to rules. This led them to use striking colour and minute, abundant detail. The paintings and poems of the group are often heavily symbolic. Many

Tate Gallery, London. Bridgeman Art Library

**This Rossetti painting** shows the Pre-Raphaelite interest in colour and simple, informal style.

are set in the distant past, and a number of them have religious and literary themes. English critics ridiculed the Pre-Raphaelites at first.

The group gained acceptance after receiving the support of English art critic John Ruskin. The group broke up in 1854. However their style had much influence in the following decades. Young painters like Edward Burne-Jones and William Morris associated themselves with Dante Gabriel Rossetti. Morris eventually founded a firm which adapted Pre-Raphaelitism into the design of stained glass, wallpaper, fabrics, carpets, and furniture.

See also **Millais, Sir John E.; Rossetti, Dante G.**

**Presbycusis.** See Ear (Diseases).

**Presbyter John.** See **Prester John.**

**Presbyterians** form a large group of Protestant denominations in English-speaking countries. Outside these countries, most churches of this tradition are called *Reformed*—for example, the Dutch Reformed Church. One motto of these churches is *semper reformanda* (ever being reformed). About 100 denominations belong to the World Alliance of Reformed Churches.

The term *presbyterian* refers to a distinctive pattern of church government. *Presbyter* is the New Testament term for *elder.* Presbyterian congregations are governed by boards, called *sessions* or *consistories,* composed of the minister and lay elders. The sessions send representatives to church councils, called *presbyteries* or *classes,* which oversee the congregations of the district. The presbyteries are represented in regional *synods* or *assemblies.* Lay elders participate equally with ministers. All the ministers have equal rank.

**Teaching and worship.** The Presbyterian and Reformed tradition has always referred to the Bible as the final authority in religious matters. Of the basic documents of Reformed theology, the two best-loved and most influential are the *Heidelberg Catechism* (1563) and the *Westminster Shorter Catechism* (1647).

The most influential theologian in the developing years of the Reformed tradition was John Calvin. He was more a commentator on the Bible than a systematic thinker. A central point in Calvin's thinking is the conviction that God is the actual present ruler over all creation.

In worship, the Reformed churches have always stressed preaching, along with the Biblical sacraments of baptism and the Lord's Supper. The formal *liturgies* (church services) during the Reformation of the 1500's were largely abandoned in favour of *free prayer* beginning in the 1600's. The Reformed churches have partly returned to set forms of worship.

**History.** Unlike Anglicanism and Lutheranism, Reformed churches often had to organize without government support, and sometimes under persecution. Many of their leaders, including Calvin and John Knox, were exiles or refugees from France, England, Scotland, the Netherlands, Germany, Italy, Poland, or Hungary.

Geneva, Switzerland, was a notable international refugee centre. From Geneva, Reformed ideas and leaders spread throughout Europe. Reformed churches were organized in nearly all European countries, each with its statement of faith, liturgy, and form of government.

The Presbyterian and Reformed churches played an important part in the great missionary movement of the 1800's. About half the member churches of the present World Alliance are "younger" churches formed in Asia, Africa, and Latin America. Presbyterian and Reformed churches have played an important role in forming united churches with other denominations. This has been the case in China, Japan, southern India, and the Philippines. The Reformed churches have also made notable contributions to national and international organizations dedicated to Christian unity.

See also **Calvin, John; Knox, John; Reformation.**

**Preschool education.** See **Early childhood education; Nursery school.**

**Prescription.** See **Pharmacy** (Duties of a pharmacist); **℞.**

**Preseli Pembrokeshire** (pop. 69,600) is the most westerly local government district in Wales. The district includes much of the Pembrokeshire Coast National Park. Tourism is an important industry. The other main industries are agriculture and oil refining. The district's main towns are Milford Haven, Haverfordwest, and Fishguard. Milford Haven is a major port. Fishguard is the terminus for a main railway line from London. There is an airport at Withybush, near Haverfordwest. The village of St. David's was once Wales's religious centre and has a cathedral begun in 1180.

See also **Dyfed.**

**Preservation, Food.** See **Food preservation; Canning industry.**

**President** is a title used by some heads of state or leaders of national governments. It is also the title of the head of a business company, corporation, college, institution, or society. This article deals with *president* as a political term.

There are 189 countries in the world, 140 of which have presidents as their heads of state. In a country ruled by a military dictator, the ruler usually takes the title *president*. See the section on unlimited presidency below.

About 124 of the world's 140 presidents are *executive* presidents. They control the making and direction of government policy in all their country's political, economic, social, and diplomatic activities. The rest are *non-executive* presidents, who act as official representatives of the country and carry out ceremonial duties.

A presidential system of government consists of separate *legislative* (law-making) and *executive* (administrative) branches. A president heads the executive branch. The president is normally elected directly by the people or, in some cases, by the legislature itself to a fixed term of office. In theory, the powers and duties of the president are almost always set out in a country's constitution. In practice, these powers are more likely to be determined by political rather than legal or constitutional issues.

There are three alternatives to the presidential political executive. In the *parliamentary executive*, the head of the government, usually the leader of the majority party in the legislature, has a clearly separate role from that of the head of state. In a *communist executive*, the Communist Party leader or general secretary heads a ruling central committee that runs the affairs of the country. In an *absolute executive*, presidential-style government is carried out according to the *decrees* (decisions) of a single individual, a family (as in a monarchy), or a military *junta*, or council.

The table with this article lists each country that has a president together with the type of presidency involved and information about the current president.

### Types of presidential government

The majority of the world's population is subject to executive presidential government. There are three types of presidency: (1) *limited*, (2) *dual*, and (3) *unlimited*. The difference between one form of presidency and another results mainly from the extent of the president's authority in relation to other members or sections of a country's government.

**Limited presidency.** Limited presidential government exists when a president is freely elected by the people for a specified term of office. In a limited presidency, a president's power is counterbalanced by that of other political institutions, such as a parliament or a country's law courts and judges. The presidency and other sections of the executive operate within the framework of a constitution or legal code. A limited presidency is usually found in liberal or democratic countries where there is a well-developed multiparty system.

Of the 124 countries with executive presidents, 82 have a limited presidential system. The United States has a limited presidential government. The whole population elects the president to a four-year term. No one is allowed to serve more than two presidential terms. The president is the country's chief executive officer, at the head of a federal civil service and of the nation's armed services. The president appoints an advisory cabinet of department secretaries and other staff retained at the White House, the official presidential residence in Washington, D.C. But the president's immense power is severely limited by a dependence on the support of the U.S. Congress (parliament) in passing laws and paying the expenses of the *administration* (government). The U.S. Supreme Court, in its role as guardian of the U.S. Constitution is another check on the president's power. For a fuller discussion of the power and duties of the U.S. president, see **President of the United States.**

The U.S. style of presidential government provides a model for such Latin American states as Argentina, Brazil, Mexico, and Venezuela, and also for the Philippines. In nearly half of the countries with a limited presidential form of government, the U.S. model has been altered by the fact that the president has appointed a prime minister to head his *cabinet* (group of advisors). In such cases, the president retains overall authority but concentrates on defence and foreign affairs and on long-term policy planning. The prime minister handles day-to-day administration and domestic affairs.

***Electoral systems.*** Most limited executive presidents are elected directly by the people. In an election using a "first-past-the-post" system, the candidate with the most votes in a single ballot wins the contest. The "absolute majority" system, requires the winning candidate to obtain over half of the votes cast in a single ballot, or in an initial vote followed by runoff ballot.

In the United States and some other countries, the president is elected by an *electoral college*, a system for the indirect election of a political candidate. Delegates to the college vote according to the wishes of the members they represent (see **Electoral college**). U.S. political parties hold elections called *primaries* in order to choose their candidate for president (see **Primary election** [The presidential primary]).

In about 60 per cent of countries with a limited presidency, the president's term of office is five years. In about 22 per cent of such countries, the presidential term is fixed at four years, and in about 16 per cent it is six years. In nine countries, including the United States, the number of presidential terms that one person may serve is limited. Some countries place a lower limit on the age at which a person may become president. In the Philippines, for example, that age is 40, and in the United States it is 35.

**Dual presidency.** A dual presidential form of government combines elements of both a presidential and a parliamentary executive system. Executive power or management of the country's affairs is shared between a president, who is elected by the people, and a prime minister, drawn from the party or coalition of parties which commands majority support within the legislature. France's Fifth Republic has a dual executive.

France's dual executive dates from 1958. The present French Constitution, which sets out the form of the presidency, was framed hastily within three months of General Charles de Gaulle's assumption of power during the political and military crisis over Algeria. The Constitution tried to combine elements of France's two political traditions: strong administrative leadership and demo-

**U.S. President Bill Clinton** applauds as South African President F. W. de Klerk shakes the hand of Nelson Mandela, who succeeded him as president in 1994. **Shankar Dayal Sharma,** *right,* became president of India in 1992.

**President Suharto** of Indonesia receives a ceremonial welcome, *above left,* as he arrives in Singapore for the 4th Association of Southeast Asian Nations (ASEAN) summit. **Russian President Boris Yeltsin,** *above right,* is in an exuberant mood during an informal walkabout in Bonn, Germany.

**President Carlos Menem** of Argentina, *right,* on a state visit to Bonn, is greeted by Richard von Weizsäcker, who was Germany's president until 1994. **Fidel Ramos,** in the picture on the right, takes the oath of office to become the 12th president of the Philippines.

cratic, legislative accountability. However, it created instead a political system halfway between a presidential and a parliamentary form of government.

The president, elected for a renewable seven-year term, has considerable formal power, including the honour of holding the titles of head of state and commander in chief of the armed services, the right to dissolve the National Assembly once a year, and the right to appoint the prime minister. The president may preside over Cabinet and Defence Council meetings, countersign ordinances, and call national referenda on key issues, usually concerning the Constitution. The appointed prime minister, who must have majority support within the National Assembly (France's parliament), has ultimate control over domestic policy-making.

It was originally intended that the president should exercise his powers in a detached, aloof manner. But the forceful personality of de Gaulle, who remained president until 1969, changed the emphasis of executive control from parliament to the president. Supported by a private advisory office based at the president's official residence, the Elysée Palace, de Gaulle exerted firm control over all policy areas in which he had an interest. He treated the prime minister, drawn from his own political party, as a mere parliamentary agent. This practice continued during the presidencies of Georges Pompidou (1969-1974) and Valéry Giscard d'Estaing (1974-1981), both conservatives, and François Mitterrand (1981-1995), a socialist.

The Socialist Party lost its parliamentary majority during mid-term National Assembly elections in 1986. Between March 1986 and May 1988, President Mitterrand was forced to appoint the leader of the chief conservative opposition party, Jacques Chirac, as prime minister. This period, when president and prime minister belonged to opposing political parties, was known in French as *cohabitation.* The prime minister claimed the executive powers granted to him by the Constitution. He reduced the status and power of the president. A second cohabitation administration, with Edouard Balladur of Chirac's party as prime minister, was formed in March 1993.

France provides a model for dual presidential systems in Afghanistan, Bulgaria, Cambodia, Estonia, Finland, Latvia, Lebanon, Lithuania, Poland, Portugal, Sri Lanka, Turkey, and Ukraine. When parliamentary and presidential elections take place at the same time, there is usually no party political split in the executive. But in countries such as France, where presidential and parliamentary elections occur at different times, political conflicts between president and legislature may occur. In Lebanon, in an attempt to preserve religious harmony, the Constitution rules that the president must be a Maronite Christian and the prime minister a Muslim.

**Unlimited presidency.** Unlimited presidential government exists when a country has a political chief executive whose authority is not subject to the checks and balances provided by a parliament or judicial system. Unlimited presidential government is not found in liberal or democratic countries. It is a feature of authoritarian nationalist and nationalistic socialist countries. Such countries are one-party states run by a strong, influential leader. The party's objectives come second to national and presidential interests. Legislatures, where they exist, have no political power and do no more than endorse the decisions of the president. Most of the countries with unlimited presidencies have only recently become independent from colonial rule. Many have tribal, ethnic, or religious differences within their borders and require a strong leadership to enable all social groups to come together into a single state. The majority of countries with unlimited presidential governments are in Africa and the Middle East.

Several unlimited executive presidents have reached their positions of power through a military coup. One example, is Hafez al-Assad in Syria. Some of the states with unlimited presidential executives have suffered recent wars and border disputes—notably Iraq and Chad. Others, such as Senegal, have long records of political stability. In states such as Indonesia and Senegal, where opposition groupings are formally tolerated and elections permitted, the governing party's control of the media and state sector resources is so strong that there is little possibility of political defeat.

Unlimited presidents have no constitutionally set limits to their terms of office and many hold on to office for much longer periods than their counterparts in liberal democratic states. For example, Kenneth Kaunda led Zambia for 27 years between 1964 and 1991, William Tubman was president of Liberia for an identical term between 1944 and 1971, and General Ne Win led Burma (Myanmar) for 26 years between 1962 and 1988. Félix Houphouët-Boigny was president of the Ivory Coast from 1960 to 1994. Hastings Kamuzu Banda ruled Malawi from 1966 to 1994. Gnassingbe Eyadema of Togo and T. N. J. Suharto of Indonesia have been presidents of their respective countries since 1967.

Saddam Hussein became president of Iraq in 1979. Hussein is head of state, head of the government, and chairman of Iraq's Revolutionary Command Council. He is considered an unpopular and aggressive ruler. Saddam Hussein led his country through two punishing wars, against Iran, and a United Nations coalition. See **Iran and Persian Gulf War.**

**Nonexecutive presidents** perform the same role of ceremonial leadership as do monarchs in states with parliamentary executives. Nonexecutive presidents provide symbolic and dignified leadership for their country, receive foreign heads of state and dignitaries, sign treaties, and award medals and honours to deserving citizens. They also review military parades and deliver unifying speeches on their country's National Day. However, unlike monarchs, they are not hereditary rulers and usually do not retain their presidential office for very long periods. Most nonexecutive presidents are elected indirectly, usually by the legislature. The nonexecutive president of the Republic of Ireland *(Uachtarán na Éireann)* is unusual in being elected by the people for a seven-year term that is renewable only once.

The authority of nonexecutive presidents is almost always strictly limited by the country's constitution. However, nonexecutive presidents usually have a range of *extraordinary,* or emergency, powers that may be employed at times of national crisis. The most significant of such powers is the right to intervene in the nomination, appointment, and dismissal of prime ministers who are unable to command a stable majority within the legislative assembly. Nonexecutive presidents may also have

## Countries with presidents

| Country | President | Became president | Type |
|---|---|---|---|
| Afghanistan | Burhanuddin Rabbani | 1992 | Dual |
| Albania | Sali Berisha | 1992 | Dual |
| Algeria | General Lamine Zéroual | 1994 | Unlimited |
| Angola | José Eduardo dos Santos | 1992 | Dual |
| Argentina | Carlos Saul Menem | 1989 | Limited |
| Armenia | Levon Ter-Petrosyan | 1991 | Limited |
| Austria | Thomas Klestil | 1992 | Non-executive |
| Azerbaijan | Heydar Aliyer | 1993 | Limited |
| Bangladesh | Abdur Rahman Biswas | 1991 | Non-executive |
| Belarus | Alexander Lukashenko | 1994 | Limited |
| Benin | Nicéphore Soglo | 1991 | Limited |
| Bolivia | Gonzalo Sanchez de Lozada | 1993 | Limited |
| Bosnia-Herzegovina | Alija Izetbegović | 1990 | Limited |
| Botswana | Ketumile Masire | 1989 | Limited |
| Brazil | Fernando Henrique Cardoso | 1995 | Limited |
| Bulgaria | Zhelyu Zhelev | 1992 | Dual |
| Burkina Faso | Blaise Compaoré | 1992 | Limited |
| Burundi | Sylvestre Nitbantunganya‡ | 1994 | Limited |
| Cambodia | Norodom Sihanouk | 1993 | Dual |
| Cameroon | Paul Biya | 1992 | Limited |
| Cape Verde | Antonio Mascarenhas | 1992 | Dual |
| Central African Republic | Ange-Felix Patasse | 1993 | Unlimited |
| Chad | Idriss Déby | 1990 | Unlimited |
| Chile | Eduardo Frei Ruiz-Tagle | 1994 | Limited |
| China | Jiang Zemin | 1993 | Dual |
| Colombia | Ernesto Samper | 1994 | Limited |
| Comoros | Saïd Mohammed Djohar | 1992 | Limited |
| Congo | Pascal Lissouba | 1992 | Limited |
| Costa Rica | Jose Maria Figueres Olsen | 1994 | Limited |
| Croatia | Franjo Tudjman | 1990 | Limited |
| Cuba | Fidel Castro†† | 1959 | Unlimited |
| Cyprus† | Clarkos Klerides | 1993 | Limited |
| Czech Republic | Vaclav Havel†† | 1993 | Non-executive |
| Djibouti | Hassan Gouled Aptidon | 1977 | Limited |
| Dominica | Crispin Sorhaindo | 1993 | Limited |
| Dominican Republic | Joaquin Balaguer | 1990 | Limited |
| Ecuador | Sixto Duran Ballén | 1992 | Limited |
| Egypt | Hosni Mubarak†† | 1981 | Limited |
| El Salvador | Armando Calderon Sol | 1994 | Limited |
| Equatorial Guinea | Tedoro Nguema Mbasogo | 1979 | Unlimited |
| Eritrea | Issaias Afewerki | 1993 | Limited |
| Estonia | Lennart Meri | 1992 | Dual |
| Ethiopia | Meles Zenawi | 1991 | Limited |
| Fiji | Ratu Sir Kamisese Mara‡ | 1993 | Limited |
| Finland | Martti Ahtisaari | 1994 | Dual |
| France | Jacques Chirac | 1995 | Dual |
| Gabon | Omar Bongo | 1986 | Limited |
| Georgia | Eduard Shevardnadze | 1992 | Limited |
| Germany | Roman Herzog | 1994 | Non-executive |
| Ghana | Jerry Rawlings | 1981 | Unlimited |
| Greece | Konstantinos Stefanopoulos†† | 1995 | Limited |
| Guatemala | Ramiro de Leon Carpio | 1993 | Limited |
| Guinea | Lansana Conte | 1984 | Unlimited |
| Guinea-Bissau | João Bernado Vieira | 1980 | Limited |
| Guyana | Cheddi Jagan | 1992 | Limited |
| Haiti | Jean-Bertrand Aristide | 1991 | Limited |
| Honduras | Carlos Roberto Reina | 1994 | Limited |
| Hungary | Arpad Goncz | 1990 | Dual |
| Iceland | Vigdis Finnbogadottir | 1980 | Dual |
| India | Shankar Dayal Sharma†† | 1992 | Non-executive |
| Indonesia | Haji Mohamed Suharto†† | 1967 | Unlimited |
| Iran | Hashemi Ali Akbar Rafsanjani†† | 1989 | Dual |
| Iraq | Saddam Hussein†† | 1979 | Unlimited |
| Ireland | Mary Robinson†† | 1990 | Non-executive |
| Israel | Ezer Weizman | 1993 | Non-executive |
| Italy | Oscar Luigi Scalfaro | 1992 | Limited |
| Ivory Coast | Henri Konan Bedie | 1993 | Limited |
| Kazakhstan | Nursultan Nazarbayev | 1991 | Limited |
| Kenya | Daniel arap Moi | 1978 | Unlimited |
| Kiribati | Teburoro Tito | 1994 | Limited |
| Korea, North | Kim Chong Il | 1994 | Unlimited |
| Korea, South | Kim Young Sam | 1993 | Limited |
| Kyrgyzstan | Askar Akayev | 1990 | Unlimited |
| Laos | Nouhak Phoumsavan | 1992 | Non-executive |
| Latvia | Guntis Ulmanis | 1993 | Dual |
| Lebanon | Elias Hrawi | 1992 | Dual |
| Libya | Muammar Mohammad al Qadhafi†† | 1969 | Unlimited |
| Lithuania‡ | Algirdas Brazauskas | 1993 | Dual |
| Macedonia | Kiro Gligorov | 1991 | Dual |
| Madagascar | Albert Zafy | 1993 | Limited |
| Malawi | Bakili Muluzi | 1994 | Limited |
| Maldives | Maumoun Abdul Gayoom | 1978 | Unlimited |
| Mali | Alpha Oumar Konare | 1992 | Limited |
| Malta | Ugo Mifsud Bonnici | 1994 | Limited |
| Mauritania | Sidi Mohammed Taya | 1992 | Limited |
| Mauritius | Cassam Uteem | 1992 | Non-executive |
| Mexico | Ernesto Zedillo Ponce de León | 1994 | Limited |
| Micronesia | Olter Bailey | 1991 | Limited |
| Moldova | Mircea Snegur | 1991 | Limited |
| Mongolia | Punsalmaagiyn Ochirbat | 1990 | Limited |
| Mozambique | Joaquim Alberto Chissano | 1990 | Limited |
| Namibia | Sam Nujoma | 1990 | Limited |
| Nauru | Bernard Dowiyogo | 1989 | Limited |
| Nicaragua | Violeta Barrios de Chamorro†† | 1990 | Limited |
| Niger | Mahamane Ousmane | 1993 | Limited |
| Pakistan | Farooq Leghari | 1993 | Non-executive |
| Palau | Kuniwo Nakamura | 1994 | Limited |
| Panama | Ernesto Perez Balladares | 1994 | Limited |
| Paraguay | Juan Carlos Wasmosy | 1993 | Limited |
| Peru | Alberto Keinya Fujimori | 1990 | Limited |
| Philippines | Fidel Ramos | 1992 | Limited |
| Poland | Lech Walesa†† | 1992 | Dual |
| Portugal | Mario Alberto Lopes Soares | 1987 | Dual |
| Romania | Ion Iliescu | 1990 | Limited |
| Russia | Boris Yeltsin†† | 1991 | Limited |
| Rwanda | Pasteur Bizimungu | 1994 | Limited |

## Countries with presidents (continued)

| Country | President | Became president | Type | Country | President | Became president | Type |
|---|---|---|---|---|---|---|---|
| São Tomé | Miguel Trovoada | 1991 | Limited | Tunisia | Zine el-Abidine Ben Ali | 1987 | Limited |
| Senegal | Abdou Diouf | 1988 | Limited | Turkey | Suleyman Demirel | 1993 | Dual |
| Seychelles | France-Albert René | 1989 | Limited | Turkmenistan | Saparmurad Niyazov | 1991 | Limited |
| Singapore | Ong Teng Cheong | 1993 | Non-executive | Uganda | Yoweri Museveni | 1986 | Unlimited |
| Slovakia | Michal Kovac | 1993 | Limited | Ukraine | Leonid Kuchma | 1994 | Dual |
| Slovenia | Milan Kucan | 1992 | Non-executive | United States | Bill Clinton†† | 1992 | Limited |
| South Africa | Nelson Rolihlahla Mandela†† | 1994 | Limited | Uruguay | Luis Alberto Lacalle Herrera | 1989 | Limited |
| Sri Lanka | Chandrika Bandaranaike Kumaratunga | 1994 | Dual | Uzbekistan | Islam Karimov | 1991 | Limited |
| Sudan | Omar Hassan Ahmad al-Bashir | 1993 | Unlimited | Vanuatu | Jean Marie Leye | 1994 | Non-executive |
| Suriname | Ronald Venetiaan | 1991 | Limited | Venezuela | Rafael Caldera Rodríguez | 1993 | Limited |
| Switzerland | Otto Stich | 1994 | Non-executive | Vietnam | Le Duc Anh | 1992 | Limited |
| Syria | Hafez al-Assad | 1971 | Unlimited | Yemen | Ali Abdullah Saleh | 1993 | Limited |
| Taiwan | Lee Teng-hui | 1988 | Limited | Yugoslavia§ | Zoran Lilic | 1992 | Non-executive |
| Tajikistan‡ | Imamoli Rakhmanov | 1992 | Limited | Zaire | Mobutu Sese Seko | 1965 | Unlimited |
| Tanzania | Ali Hassan Mwinyi | 1990 | Limited | Zambia | Frederick Chiluba | 1991 | Unlimited |
| Togo | Gnassingbe Eyadema | 1967 | Non-executive | Zimbabwe | Robert Mugabe†† | 1987 | Limited |

*President is in exile. **Interim president.
†Northeastern Cyprus does not recognize the president of the Republic of Cyprus. Since 1974, northeastern Cyprus has considered itself a separate independent state, but no other country apart from Turkey recognizes it as independent. ‡Acting president.
§Yugoslavia includes the republic of Serbia. The president of Serbia is Slobodan Milosevic.
Each country has an article in *World Book*. ††President has an article in *World Book*.

the right to dissolve the legislature and call fresh elections. Usually, this right is exercised when legislative elections produce a "hung assembly," in which no clear majority grouping is evident. Nonexecutive presidents have used this power regularly and controversially in Pakistan since 1990, where the president has threatened to assume an authority comparable to that of a dual executive.

In some countries, such as the Republic of Ireland, the president guards the constitution, calls the legislature into session, and signs laws passed by it. The president may refuse to sign a law that appears to conflict with or threaten the constitution and can refer it back to the supreme court for a ruling.

The nonexecutive president of Germany has unusually limited powers. The reasons for this are historical. During the Weimar Republic (1918-1933), Germany had a dual executive political system. The president, directly elected by the people to a seven-year term, had great power. He worked with a *chancellor* (prime minister), who needed the confidence of both the lower house of the legislature and of the president. However, the electoral system, based on almost pure proportional representation, promoted political instability (see **Proportional representation**). From 1925, power shifted into the hands of the conservative president von Hindenburg. In January 1933, he invited Adolf Hitler to become chancellor. The eventual result of this act was the outbreak of World War II (1939-1945).

In reaction to this experience, the framers of the Constitution of the new Federal Republic of Germany in 1949 deliberately set out to cut the president's powers. The German president is now appointed, for a maximum of two five-year terms, by a Federal Convention composed of the members of the directly elected lower chamber of the federal legislature, the Bundestag, and an equal number from *Land* (state) assemblies. In effect, the president of Germany is a party and parliamentary nominee, a ceremonial figurehead with very few powers of intervention. For the current president of Germany, see the table earlier in this article.

### History

The title president comes from the Latin words *praeses* and *praseidens* and means "one who presides, rules, or directs". In classical Rome, the title *praeses* was given to the governors of provinces. Later, during the Middle Ages the titles *praeses* and *praesidens* were given to royal officials to whom power was delegated within the provinces.

In its modern meaning, the term *president* dates from the late 1700's. The title was first used by heads of the councils of the North American colonies, including New Hampshire, Pennsylvania, and South Carolina. Then, during the revolutionary struggle which occurred in America between 1774 and 1789, the presiding officer of the Continental Congress was called "President of the United States in Congress assembled". This title was transferred to the head of the federal United States government when the federated states' constitution was adopted in 1787. George Washington was inaugurated as the first president of the United States in 1789. See **United States, History of the.**

During the 1800's, the United States' example of an elected executive president was followed by newly emerging democratic republics, notably the newly independent South American countries. France and Switzerland both adopted a presidential system. So did Liberia, a West African state founded as an independent republic by liberated black slaves from the southern United

**Mary Robinson,** first woman president of the Republic of Ireland, was awarded a *degree by diploma* at Oxford University, the United Kingdom, in 1993. This honour is reserved for heads of state and the British Royal Family.

States. An executive presidential system was also created in the new Turkish Republic in 1923.

Since World War II, the number of states with presidential systems of government has increased greatly due to the formation of newly independent states in Africa, Asia, and the Americas and the downfall of Communist regimes in eastern Europe. Since 1991, Russia has had an executive president elected by the people. Boris Yeltsin has had to contend with many challenges to his authority by the Russian legislature, the Congress of People's Deputies, a survival of former Communist days. Most postwar presidents are executive presidents.

**Women as presidents.** The world's first woman president was Isabel Perón. She succeeded her husband, Juan Domingo Perón, as president of Argentina on his death in July 1974, but, within 20 months, she was deposed in a bloodless coup. The first woman to be democratically elected as a presidential head of state was Vigdis Finnbogadottir in Iceland in 1980.

Corazon Aquino led the Philippines as president between 1986 and 1993, and Violeta Barrios de Chamorro, became president of Nicaragua in 1992. All these women served as limited executive presidents. Mary Robinson became the Republic of Ireland's first woman president in 1990. She is a nonexecutive president.

**Related articles** in *World Book.* See the *Government* and *History* sections of each country article. See also:

Election
Monarchy
Parliament
President of the United States
Veto
White House

**President of the United States** is often considered the most powerful elected official in the world. The president leads a country of great wealth and military strength.

The Constitution of the United States gives the president enormous power. However, it also limits that power. The authors of the Constitution wanted a strong leader as president, but they did not want an all-powerful king. As a result, they divided the powers of the United States government among three branches—executive, legislative, and judicial. The president, who is often called the *chief executive,* heads the executive branch. Congress represents the legislative branch. The Supreme Court of the United States and other federal courts make up the judicial branch. Congress and the Supreme Court may prevent or end any presidential action that exceeds the limits of the president's powers.

As chief executive, the president makes sure that federal laws are enforced. As commander in chief of the nation's armed forces, the president is responsible for national defence. Only the president can decide to use nuclear weapons. As foreign policy director, the president determines United States relations with other nations. As legislative leader, the president recommends laws and works to win their passage. As head of a political party, the president helps mould the party's positions on national and foreign issues. The president also tries to inspire the people to work together to meet the country's goals. Finally, as chief of state, the president performs various ceremonial duties.

**The presidency.** The Constitution establishes only three qualifications for a president. A president must (1) be at least 35 years old, (2) have lived in the United States for 14 years, and (3) be a natural-born citizen.

The president is elected to a four-year term. No one may be elected president more than twice.

The Constitution allows Congress to remove a president from office. The president first must be *impeached* (charged with wrongdoing) by a majority vote of the House of Representatives. Then, the Senate, with the chief justice of the United States serving as presiding officer, tries the president. Removal from office requires conviction by a two-thirds vote of the Senate.

**Related articles** in *World Book.* See the separate biographies of each president. Other articles include:

Camp David
Electoral College
Hot line
Impeachment
Political parties
President
Primary election
United States, History of the
Veto
White House

**Presidents of the United States since 1900**

| President | Served | Political party |
|---|---|---|
| William McKinley | 1897-1901 | Republican |
| Theodore Roosevelt | 1901-1909 | Republican |
| William H. Taft | 1909-1913 | Republican |
| Woodrow Wilson | 1913-1921 | Democratic |
| Warren G. Harding | 1921-1923 | Republican |
| Calvin Coolidge | 1923-1929 | Republican |
| Herbert C. Hoover | 1929-1933 | Republican |
| Franklin D. Roosevelt | 1933-1945 | Democratic |
| Harry S. Truman | 1945-1953 | Democratic |
| Dwight D. Eisenhower | 1953-1961 | Republican |
| John F. Kennedy | 1961-1963 | Democratic |
| Lyndon B. Johnson | 1963-1969 | Democratic |
| Richard M. Nixon | 1969-1974 | Republican |
| Gerald R. Ford† | 1974-1977 | Republican |
| Jimmy Carter | 1977-1981 | Democratic |
| Ronald Reagan | 1981-1989 | Republican |
| George H. W. Bush | 1989-1993 | Republican |
| Bill Clinton | 1993- | Democratic |

†Inaugurated Aug. 9, 1974, to replace Nixon, who resigned the same day.

**Presidium.** See **Politburo.**

**Presley, Elvis** (1935-1977), became the most popular American singer in the history of rock music. He was one of the first stars of rock music.

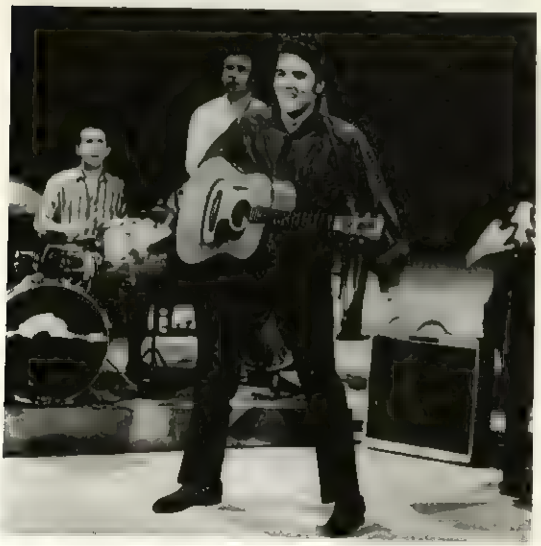
Elvis Aron Presley was born in Tupelo, Mississippi, U.S.A. During his childhood there, he was exposed to the music that shaped his later singing style, including country music, rhythm and blues, and gospel. When he was 13 years old, Presley moved with his family to Memphis, Tennessee. He began recording there for Sun Records in 1954.

In 1955, Colonel Tom Parker, a successful promoter of country and western singers, became Presley's manager. Presley's recordings for Sun Records caused an immediate sensation. He became even more popular in 1956 when RCA Victor bought his contract and issued the chart topping "Heartbreak Hotel." Other hits quickly followed, including "Don't Be Cruel," "Hound Dog," and "Love Me Tender." By the end of 1956, Presley was a national celebrity. He added other hits in 1957 and 1958, notably "All Shook Up" and "Jailhouse Rock."

Presley's early fame resulted partly from his controversial concert performances. On stage, he adopted a tough, rebellious manner and used sexually suggestive movements that excited teenagers but offended many adults. In 1956, he made his film debut in *Love Me Tender.*

From the late 1960's until his death, Presley recorded many songs with slower rhythms and more traditional melodies. This style won him popularity with older audiences. His later songs included "In the Ghetto" (1969), "Suspicious Minds" (1969), "The Wonder of You" (1970), and "Kentucky Rain" (1970).

Controversy surrounded Presley's death at the age of 42. Late in his life, Presley took many drugs for numerous illnesses, for insomnia, and to lose weight. Some people believe drugs hastened Presley's early death.



**Elvis Presley,** *above,* rehearses for a 1956 appearance on a U.S. TV show. Presley's appearance on the show helped establish him as a national celebrity.

Presley was buried in Graceland, his home in Memphis. Graceland has become a major tourist attraction. Since his death, Presley has become an even more mythic figure, and there have been frequent rumours that he is still alive. The devotion of his fans can be almost a religion to them. Presley is considered by many to be the single most influential and respected figure in the history of rock.

See also **United States** (picture: Popular music).

**Pre-Socratic philosophy** is a term for the theories developed by Greek philosophers from about 600 B.C. to 400 B.C. These philosophers are called *pre-Socratic* because most of them preceded Socrates, the famous philosopher of Athens. The pre-Socratics tried to understand and explain the natural universe in terms of natural principles. They developed conflicting theories but shared a basic interest in the origin and natural processes of the universe. The pre-Socratics laid the foundation for the work of later philosophers.

Scholars know little about the pre-Socratics. Their knowledge comes mainly from fragments of pre-Socratic writings and the works of later writers.

**The first pre-Socratics** lived in Miletus, a Greek city in Asia Minor, during the 500's B.C. These philosophers believed the universe originated from, and is composed of, one basic substance. The first known pre-Socratic, Thales, taught that water was this substance. Another member of the group, Anaximander, thought the universe came from an eternal stuff that he called the *indefinite.* Anaximenes theorized that air was the basic substance and that it condensed or became less dense to form other materials, such as water or fire.

At about the same time, in what is now southern Italy, Pythagoras explained the universe in terms of numbers. He taught that all things are numbers or, perhaps, could be reduced to numbers. Pythagoras also believed that everything is harmoniously related. On the other hand, Heraclitus saw only strife in the world. He thought that everything constantly changes and moves, and that nothing remains the same.

**The teachings of Parmenides,** which became influential during the 400's B.C., raised a problem for other pre-Socratics. Until then, philosophers had accepted the existence of change, motion, and *plurality* (reality consisting of many substances). Parmenides held that change, motion, and plurality are unreal because they require the existence of *what is not.* Parmenides rejected the idea of *what is not* as inconceivable. He said the universe is uniform, immovable, and unchanging, with no generation or destruction.

Parmenides had great influence but few followers. His opponents could not disprove his reasoning, and so they tried to reconcile his conclusions with common sense. Empedocles agreed that there could be no generation or destruction. He explained the apparent existence of such things in terms of four eternal elements—earth, air, fire, and water—mixed by the force of *love* and separated by *strife.* He believed that all objects in the universe are made up of these four elements. Anaxagoras believed that an infinite number of elements had been separated out of an original mixture through the rotation initiated by a force he called *Mind.* Each thing contains all the elements but in different proportions. Anaxagoras thought matter was infinitely divisible.

In the late 400's B.C., Leucippus and Democritus responded to Parmenides with a theory called *atomism.* They taught that the universe consists of tiny, solid, indivisible bodies called *atoms,* which move about in space and cluster together to form the larger objects of common experience.

**Related articles** in *World Book* include:

| | | |
|---|---|---|
| Anaxagoras | Empedocles | Pythagoras |
| Anaximenes | Heraclitus | Socrates |
| Atomism | Parmenides | Thales |

**Press.** See **Journalism; Newspaper; Printing; Freedom of the press.**

**Press gangs** were groups of seamen used to obtain *conscripts* (involuntary recruits) for Britain's Royal Navy until the early 1800's. Conditions of life in the navy before that time were so bad that it was almost impossible to find volunteers. Press gangs scoured the streets of naval towns and the surrounding districts. They seized any able-bodied man they could find and sent him under escort to serve at sea. Hatred of the press gangs, who had the right to separate men from their families, sometimes led to violent demonstrations.

**Pressburg.** See **Bratislava.**

**Pressure** is defined as force per unit area. In physics, the term is usually applied to *fluids* (gases or liquids). If a fluid is exposed to suitable forces, pressure is produced in it. The greater the force, the greater the pressure. Pressure is measured in kilograms per square centimetre or pascals in the metric system. It is measured in pounds per square inch in the imperial system.

Atmospheric pressure is one of the most common examples of pressure. It is produced by the weight of the air from the top of the atmosphere as it presses down upon the layers of air below it. At sea level, the average atmospheric pressure is 101.3 kilopascals. This decreases with altitude because less air is pressing from above.

If a fluid is at rest, pressure is transmitted equally to all its parts and, at any one point, is the same in all directions. The fluid acts this way because the molecules in it move freely. The molecules are far apart in a gas and comparatively close together in a liquid.

In the 1650's, the French scientist Blaise Pascal discovered the fact that pressure in a fluid is transmitted equally to all distances and in all directions. He formulated *Pascal's law* to describe the effects of pressure within a liquid (see **Pascal's law**). This law has many practical applications.

The greater the pressure in a gas, the smaller its volume. This decrease in volume occurs because the molecules are pushed closer together. Under ordinary conditions, the volume of a gas decreases by half when the pressure doubles. The law that describes how the volume of a gas changes when the pressure changes is called *Boyle's law,* after Robert Boyle, the Irish scientist who first published it. The volume of liquids and solids also decreases when pressure increases, but by very much smaller amounts than for gases.

The ability of a gas to compress and expand has many practical uses. Air tyres, air cushions, and air brakes are based on this elasticity of air.

Pressure changes the boiling point of water. The boiling point is that temperature at which the pressure of the steam is equal to the atmospheric pressure. At sea level, the two pressures are equal at 100° C. As height above sea level increases, the pressure decreases, and the boiling point becomes lower and lower. This makes cooking at high altitudes difficult, because the cooking of food depends upon the temperature to which the food is heated, not on whether the surrounding water is boiling. See **Boiling point.**

Atmospheric pressure plays an important part in our daily lives. Wind is the movement of air from a point of high pressure to a point of low pressure. Pressure changes precede storms. Barometers detect storms by measuring such changes.The first barometers used the height of a column of mercury in a tube to measure atmospheric pressure. A pressure of 101.3 kilopascals is indicated by a 760 millimetre column of mercury.

**Related articles** in *World Book* include:

| | | |
|---|---|---|
| Air | Gas | Hydraulics |
| Barometer | Gauge | Manometer |

**Pressure gauge.** See **Gauge.**

**Pressure sore.** See **Bedsore.**

**Press gangs** recruited men into Britain's Royal Navy by force. Many of the men who helped Britain to control the seas during the Napoleonic Wars were "pressed" into service.

**Prester John** (or *Presbyter John*) was a legendary Christian priest and king. He is supposed to have lived in the 1100's. Many travellers of the Middle Ages, including Marco Polo, claimed that he ruled a vast kingdom in central Asia. Later reports, especially by Portuguese explorers, made him the emperor of Ethiopia. Pope Alexander III sent a messenger to look for him in 1177, but the messenger never returned.

**Prestidigitation.** See **Magician.**

**Preston** (pop. 126,200) is the administrative centre of the county of Lancashire, in England. It is situated about 45 kilometres northeast of Liverpool. The town stands at the head of the estuary of the River Ribble. The estuary is navigable as far as the town by ocean-going ships, and has important docks. Industries in the town make cotton and rayon textiles, and textile and electrical machinery. Preston is also the name of the local government district, which includes the town. See also **Lancashire; New town.**

**Prestwick** is a small town in Strathclyde Region, in southern Scotland. It is internationally known for its airport, which serves flights from many parts of the world. Prestwick is also a holiday resort. It is about 5 kilometres north of Ayr. It overlooks the Firth of Clyde.

**Pretenders** were two claimants to the throne of England, the son and the grandson of James II.

**James Edward Stuart** (1688-1766), the Old Pretender, was the eldest son of James II. His birth was one of the causes of the Revolution of 1688. Parliament had barely tolerated the king's Roman Catholicism. When he produced an heir, feeling against him rose even higher. In 1701, the Act of Settlement excluded the Stuarts from succeeding to the English throne. In 1714, after the death of Queen Anne, a section of the Tory party led by Viscount Bolingbroke attempted to put James Edward on the throne but failed, partly because James refused to become a Protestant. James ordered the Jacobite Rising of 1715 (see **Jacobite risings**). Later he lived in Rome.

**Charles Edward Stuart** (1720-1788), the Young Pretender, was the son of James Edward Stuart. He was known as *Bonnie Prince Charlie.* In 1745, he landed at Moidart, in Scotland, and began the second Jacobite Rising on behalf of his father. He escaped after the Battle of Culloden (1746) and lived in France and Italy.

**Pretoria** (pop. 525,583; met. area pop. 1,025,790) is the administrative capital of South Africa and its fourth largest city. It lies in the north of Gauteng province. Its municipal area is 630 square kilometres. Pretoria has a large number of government departments, and thousands of civil servants work there.

The city lies in the foothills of the Magaliesberg mountains. Owing to its lower altitude, it is warmer than the nearby city of Johannesburg. Pretoria is famous as the *Jacaranda City,* because of the jacaranda trees that bloom there.

**The city.** Pretoria lies in two sheltered and fertile valleys. Several ridges run through the city from east to west. The main river is the Apies, which is spanned by 12 bridges.

Pretoria's climate is generally warm and sunny. Temperatures in the summer range from 15 to 28 °C. The mean annual rainfall is 70 centimetres. Winters are sunny and mild, temperatures ranging from 6 to 23 °C. Frost seldom occurs. Vegetation is lush, with large areas of grassland and some well-shrubbed and wooded areas.

Church Square is the centre and the point of origin of Pretoria. Church Street is the main street running from the square to the west. It is over 25 kilometres long and is one of the longest straight streets in the world. Paul Kruger Street is the main street running north to south through Church Square. The central business district is located around the square. The main residential areas lie to the north, east, and south. Mamelodi and Atteridgeville were originally established as residential areas for Africans. The main industrial areas are Waltloo and Rosslyn.

There are 140 parks and gardens in the city. These include Burgers Park, Fountains Valley (the first nature reserve in Africa), Austin Roberts Bird Sanctuary, National Botanical Gardens, National Zoological Gardens, and the Aquarium and Snake Park.

Pretoria's landmarks include the Union Buildings (the administrative headquarters of the government), the Voortrekker Monument, and the futuristic architecture of the University of South Africa.

**People.** Many of Pretoria's people are of African descent. Languages which are commonly spoken in the Pretoria area include North Sotho, South Sotho, Tswana, Xhosa, and Zulu. People who speak either Afrikaans or English as a first language make up around half the city's population. People of Asian descent and people of mixed ethnic origin account for about 5 per cent of the population.

Heroes' Acre is a cemetery where many of Pretoria's famous people are buried, including Andries Pretorius, Johannes Strijdom, and Hendrik Verwoerd. The Miriammen Temple, the oldest Hindu Temple in South Africa, was built in 1905. There are numerous churches, cathedrals, and mosques.

**Education and cultural life.** Pretoria has South Africa's largest concentration of academics, researchers, scientists, and libraries. The University of South Africa (UNISA) is a large correspondence university. The University of Pretoria, established in 1930, is the largest residential university in South Africa. The university's faculty of veterinary science is at Onderstepoort, north of Pretoria. Onderstepoort is South Africa's leading school for veterinary surgeons. Medunsa (the Medical University of South Africa) is in Ga-Rankuwa, north of Pretoria.

The State Theatre is the base of the Performing Arts Council of the Transvaal. Operas, ballets, drama, dance, and music are staged there, as well as in the City Hall.

Pretoria's main sports stadium is the Loftus Versfeld Stadium. The city's numerous museums include the Pretoria Art Museum, Pierneef Museum, and the National Cultural History and Open Air Museum.

**Economy.** Pretoria is essentially a business and service centre. The major industrial products are cars, furniture, glass, paper, and tobacco. The largest brewery in the Southern Hemisphere is in Pretoria. The steel works were set up in 1928. Wonderboom is the local airport, and Jan Smuts International Airport is 50 kilometres away from Pretoria.

The majority of Pretoria's population work in the service sector. This includes the civil service, administration, and social services. About 16 per cent of the people

**Pretoria** is called the *Jacaranda City* because of the beauty of its jacaranda trees in bloom. The city is the administrative capital of South Africa.

work in the manufacturing industry and 13 per cent in commerce. Construction, finance, and transportation each employ about 5 per cent.

**Government.** The Pretoria municipality provides services and manages the city. The city also houses the Mint, the Government Printer, and the military headquarters of the South African Defence Force.

**History.** In the early 1600's, Nguni-speaking people of the Ndebele group settled in the Pretoria area. Zulu joined them later. In the mid-1800's, group of *Voortrekker* families (Afrikaners who migrated from the Cape Colony) settled in the Transvaal. The main settlements were at Potchestroom and Lydenburg. In 1855, Marthinus Wessel Pretorius established a permanent settlement. Pretoria was named after Pretorius and his father, Andries Wilhelmus Jacobus Pretorius.

The Transvaal was renamed the Zuid-Afrikaansche Republic and in 1860, Pretoria became its headquarters. The town played a part in the Boer Civil War (1863-1869). In 1894, the railway from Delagoa Bay on the Indian Ocean reached Pretoria. The Treaty of Vereeniging ending the Second Anglo-Boer war was signed by the United Kingdom in Pretoria in 1902. In 1910, Pretoria was named as capital of the Union of South Africa and administrative capital of the Transvaal province. Pretoria became the administrative capital of the Republic of South Africa in 1961.

When the Pretoria-Witwatersrand-Vereeniging (PWV) Province (now Gauteng) came into being in 1994, the administration of the new province passed to Johannesburg, and Pretoria ceased to be a provincial capital. On May 10, 1994, world attention focused on Pretoria when Nelson Mandela was inaugurated as the first president of a nonracial, democratic South Africa. More than 50,000 people, including about 45 heads of state and dignitaries from more than 175 countries, attended the event held at the Union Buildings. Also in 1994, Pretoria submitted a plea to the national government to be considered as South Africa's legislative capital.

See also **South Africa.**

**Pretoria-Witwatersrand-Vereeniging.** See Gauteng.

**Pretzel** is a type of German biscuit. It is brittle and twisted, with a glazed, salted surface. *Pretzel* comes from the Latin word *pretiola,* meaning *a small reward.* The pretzel was first made by monks in southern Europe as a reward for children who learned their prayers. Its shape represented the crossed arms of a child praying.

**Prevailing westerly** is a wind that blows over the North and South middle latitudes from west to east. In the Southern Hemisphere, prevailing westerlies over the sea blow with such force that sailors call this region the "roaring forties." Over the land masses of the Northern Hemisphere, the westerlies are often turned from their course by mountain ranges.

**Preventive medicine.** See **Medicine** (Prevention); **Holistic medicine.**

**Prévert, Jacques** (1900-1977), was probably the most popular French poet of the mid-1900's. His *Paroles (Spoken Words),* became an immediate best seller when it appeared in 1946. Prévert's poems are rich in the clever use of words and humour. They declare the need for individual happiness and love, and attack with playful mockery the most respected human institutions. The simple sentence structure of many of the poems makes them favourites in French courses for beginners.

Prévert was born in Neuilly-sur-Seine, France. He joined the surrealist movement during the 1920's, and his poems are typical of surrealism. Prevert also wrote the scripts for several feature films directed by Marcel Carné.

**Previn, André** (1929- ), is an American conductor, pianist, and composer. Previn served as conductor of the Houston Symphony Orchestra, in America, from 1966 to 1969. He was conductor of the London Symphony Orchestra from 1968 to 1979. He served as music director of the Pittsburgh Symphony Orchestra, in America, from 1976 to 1984. Previn became music director of both the Los Angeles Philharmonic and London's Royal Philharmonic in 1985. He resigned his Los Angeles position in 1989. As a pianist, Previn achieved success playing both classical music and jazz. He composed and arranged music for several films and recordings, and he received four Academy Awards for his film work. Previn

Previn was born in Berlin, Germany. His family settled in the United States in 1939, and he became an American citizen in 1943.

**Priam,** in Greek mythology, was the last king of Troy and ruler of the city during the Trojan War with Greece. He was noted for his kindness, dignity, and respect for the gods. Priam's wife was Hecuba (or Hecube). Priam had 50 sons and 50 daughters by Hecuba and various other women. The most famous were his sons Hector and Paris and his daughter Cassandra.

Most of Priam's sons died in the war. The king went alone at night to the tent of the Greek warrior Achilles to beg for Hector's body so he might give it a proper burial. Achilles pitied the old man and returned the body to him. Later, as Priam clung to the altar of Zeus on the night that Troy fell, Achilles' son Neoptolemus (or Pyrrhus) killed him.

See also **Hecuba; Iliad; Paris** (mythology).

**Pribilof Islands** are four hilly islands in the Bering Sea. They are the home of the world's largest fur seal herd. Each spring, about 1 ½ million fur seals go to the Pribilofs to breed. The Pribilofs include the large islands of St. Paul and St. George, and the smaller islands of Otter and Walrus. They cover almost 200 square kilometres and have a population of about 900 people. The United States obtained the islands when it bought Alaska in 1867. For the location of the Pribilof Islands, see **Alaska** (physical map).

For many years, there were no restrictions on hunting the seals. As a result, they almost became extinct. In 1911, the United States, Russia, Great Britain, and Japan signed a treaty in which they agreed to protect the seals, and the United States received charge of the herd. In 1957, the United States, Canada, the Soviet Union, and Japan agreed to restrict seal hunting to the Pribilofs and two Soviet islands. The treaty expired in 1984. Since then, animal protection laws have prevented commercial hunting of fur seals around the islands.

In 1786, the Russian explorer Gerasim Loginovich Pribylov (also spelled Pribilof) discovered the islands. They were uninhabited. Russian traders brought Aleuts from the nearby Aleutian Islands to the Pribilofs to help hunt seals. The Aleuts continued to settle there. Today, St. Paul has more than 500 people. It is Alaska's largest Aleut community.

See also **Bering Sea controversy; Seal.**

**Price** is the amount of money for which something can be bought or sold. The price states the worth in money of a unit of a certain good or service. This article discusses how prices are determined and what prices do in *free market systems.* These systems, in which people carry out their economic activities largely free from government control, operate in most Western democracies. In *planned economies,* such as those of some Communist nations, the government determines most prices.

### How price is determined

**Demand and supply.** Prices are based on the economic forces of *demand* and *supply. Demand* is the quantity of a good or service that consumers are willing and able to buy. *Supply* is the quantity producers and other people are willing and able to offer for sale.

Demand usually varies according to a product's price. The lower the price, the greater the demand. This is because people who want the product will buy more of it at a lower price and because the low price will attract new buyers. The tastes and incomes of buyers and potential buyers also determine demand. In addition, demand for one product may be affected by the prices of related products. For example, if an increase in the price of cars causes people to buy fewer cars, there will be less demand for car tyres.

Supply also varies with prices, but in the opposite way from demand. In many cases, the higher the price, the greater the quantity producers want to supply. But the main thing that determines supply is the cost of production, which depends primarily on the costs of labour, materials, and capital. The cost of production may increase or decrease as greater quantities are produced, with an associated increase or decrease in price.

In a free market system, the price of a product tends to settle at an *equilibrium price.* This is a price at which buyers are able to purchase all they want, and at which sellers are able to sell all they wish to sell. As the conditions of supply and demand change, the equilibrium price moves up or down.

**Monopoly.** The price of a product may be affected by special circumstances. For example, a company or individual may gain a *monopoly*—that is, it may control the supply of a product for which there is no close substitute. The company or individual may use its *monopoly power,* or *market power,* to raise the product's price. It may raise the price above whatever equilibrium price would have been achieved under competition. Because there are no close substitutes for the product, consumers will have to pay the high price.

**Government intervention** in the market, through *price controls* or other means, also affects prices. Various price controls may benefit producers or consumers. A *ceiling price* is a maximum price that is designed to help a certain group of consumers. For example, some authorities put ceiling prices on rental units to limit the amount of rent a landlord may charge a tenant. A *floor price* is a minimum price established by a government or other official body. This price is designed to aid certain producers. For example, the New Zealand government has established floor prices, known as *support prices,* for many agricultural products to help farmers gain profits. The government helps maintain a support price partly by buying certain quantities of the product when the market price falls below the floor price. In this way demand is increased, causing the price to rise.

Other types of price controls, such as a *price freeze,* may be used. This method holds prices at a certain level, such as the level they were at when the price freeze went into effect.

Although interventions help solve some problems, they may cause others. For example, when an effective support price is set above the equilibrium price, a *surplus* of the product may result. Low prices caused by ceiling prices may cause shortages by increasing demand for a product or by decreasing supply.

### What prices do

In a free market system, an equilibrium price *clears the market*—that is, it satisfies buyers and sellers. Price systems thus ration products, distributing them to people willing and able to pay for them.

Prices help determine what goods and services should be produced, how they should be produced, and for whom they should be produced. Consumers let producers know what to produce by indicating the prices they are willing to pay for particular goods and services. Producers decide how to produce goods and services based on the prices of materials and labour. How much people can afford to buy determines for whom goods are produced.

**Related articles** in *World Book* include:

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|---|---|---|
| Capitalism | Marketing (Pricing) | Price control |
| Discount | Monopoly and competition | Supply and demand |
| Economics | | Value |
| Inflation | | |

**Price, Leontyne** (1927- ), an American singer, ranks among the most celebrated sopranos of her time. Her brilliant voice has an exciting vibrating quality and an unusually wide range. Price has gained acclaim both for her concert recitals and for her opera performances. The title role in the opera *Aida* is perhaps her most famous operatic part. Her performance in the role in 1960 at La Scala in Milan, Italy, made her internationally famous. She was the first black woman to sing a leading role with that famous opera company.

**Leontyne Price**

Price was born in Laurel, Mississippi, U.S.A. She made her first appearance at the Metropolitan Opera in New York City in 1961 in *Il Trovatore.* She received the Presidential Medal of Freedom in 1964 and the Spingarn Medal in 1965. Price retired as an opera performer in 1985.

**Price, Richard** (1723-1791), was a Welsh Nonconformist minister and an influential writer. In 1741, he went to London, where he became a minister. In 1757, he published a major work on morality. In 1769-1770, he wrote papers on how to calculate insurances. From Price's influential pamphlet *Civil Liberty,* published in 1776, the American Colonists learned to base their cause on an appeal to the rights of man. Price was born at Llangeinor, near Bridgend, Mid Glamorgan, Wales.

**Price control** is a method used by a government to influence prices for the benefit of producers or consumers. Price controls are often used to prevent prices from rising too rapidly. A government may establish the maximum price that can be charged for certain goods or services. It may freeze prices where they were when the controls became effective. Or a government may establish a minimum price that can be charged.

Governments may use price controls to fight *inflation,* a decrease in the purchasing power of money (see **Inflation**). Inflation benefits some people at the expense of others, and so it can disrupt production and cause social disorder. For example, workers may strike for higher pay if the cost of living rises faster than wages.

In centrally planned economies, it is usual for the government to control prices. In developing countries, the prices of essential goods, such as basic foods and fuel, are often fixed. In other countries, price controls have been used chiefly during wartime, when heavy government spending makes inflation most dangerous. The controlling of prices is often part of a government's wider prices and incomes policy. If wages and prices increase too quickly, the balance of payments may be affected. But if wages rise and the prices do not, companies may not be able to make a profit and could go out of business. The success of price controls depends primarily on (1) how vigorously the government enforces the price controls and (2) public cooperation.

See also **Rationing; World War II.**

**Prickly ash** is one of a group of trees or shrubs. The name refers to the sharp prickles on the twigs. It is also based on the similarity between the leaves of the prickly ash and those of the true ash (see **Ash**). Different species of prickly ash are found in Australia, Asia, Africa, and North and Central America. The *northern prickly ash* of North America is called *toothache tree* because the bark produces a cooling sensation when chewed, and acts as an anaesthetic for toothache. Some species bear fruit which are used as spices. Others are useful for their timber. The leaves, bark, and seeds of many types are used as remedies for snake bites, stomach disorders, and rheumatism.

**Scientific classification.** The prickly ash belongs to the rue family, Rutaceae. The northern prickly ash is *Zanthoxylum americanum.*

**Prickly heat** is a skin rash of tiny, red pimples that itch. It is also called *heat rash.* It may appear often when the weather is warm and moist. The rash occurs where the skin would normally be sweaty. It is common among infants. Prickly heat is due to blocking of sweat pores so that sweat cannot reach the surface in the usual way. It is relieved by keeping the skin cool with cool compresses and mild dusting powders. The disorder is annoying, but not harmful.

**Prickly pear,** also called *nopal* or *cholla,* is a type of cactus with prickly fruit that are shaped somewhat like a pear or fig. Many species of prickly pears grow in dry parts of the southwestern United States and northern

**The prickly pear** has pear-shaped fruit that is good to eat. The fruit grows from the edges of thorny, leaflike stems.

Mexico. They can stand long periods with little water, but they grow better with moderate rainfall, as in parts of Florida, southern Brazil, and northern Argentina.

The stem of the prickly pear consists of a series of flat, leaflike segments called *joints*. The flowers and fruit grow on the edges of the joints. In Mexico and Central America, the edible kinds are called *tuna*. The fruit are common in markets throughout Latin America. The American horticulturalist Luther Burbank developed spineless varieties, which are raised as food for people and livestock (see **Burbank, Luther**).

Prickly pears have been introduced into Mediterranean countries, India, Sri Lanka, South Africa, the Canary Islands, and Madagascar. The chief reason for their widespread cultivation is their food value and, formerly, their use in the cochineal dye industry. The cochineal insect, which gives a red dye, feeds on prickly pears.

One species of prickly pear was introduced into Australia in 1788 for a cochineal dye industry that was never established. Later, two other species were introduced as curiosities. After 1900, they spread so quickly that they soon became dangerous pests. By 1925, they had made about 12 million hectares useless for crops or grazing. The Australian government then brought in an Argentine moth, *Cactoblastis cactorum*. Its larvae live within the so-called leaves and destroy them. Within seven years, most prickly pears had been destroyed.

**Scientific classification.** Prickly pears belong to the cactus family, Cactaceae. They are members of the flat-stemmed group of genus *Opuntia*.

See **Cactus** (picture).

**Pride's Purge** was one of the most decisive events of the English Civil War. It was the forcible exclusion of certain members of Parliament (MP's) from the House of Commons in 1648, because they favoured peace with King Charles I.

By 1647, Parliament and the army had defeated Charles I. But after making a secret alliance with the Scots, Charles renewed the war in 1648. Oliver Cromwell routed an invading Scots army at Preston and quickly ended the war in England. Many MP's still favoured making a treaty with the king. But the victorious army demanded his death. On Dec. 6, 1648, Colonel Thomas Pride surrounded the House of Commons with a troop of soldiers. He forced his way into the Commons chamber and arrested more than 40 MP's. About 90 others were forcibly kept outside. After this purge, the king went on trial in January 1649, and was convicted and executed. See **Civil War, English.**

**Priest,** in many religions and religious denominations, is the title of certain members of the clergy. A priest primarily performs religious ceremonies and gives religious advice. The word *priest* comes from the Greek word *presbyteros*, which means *elder*.

Religions that have a priesthood include Buddhism, Hinduism, Shinto, and Taoism. In Christianity, the Anglican, Eastern Orthodox, Mormon, Roman Catholic, and Scandinavian Lutheran denominations use the term priest. Many of these priests serve as pastors of local churches. In ancient times, Judaism had a class of priests, led by a high priest (see **High priest**). Today, however, Judaism has no priesthood.

Many religions teach that the priesthood includes special authority to transmit sacred power to others through ceremonies. In Hinduism, for example, only *Brahmans* (priests and scholars) may perform ceremonies that involve reciting lines from scriptures known as the Vedas. Hinduism teaches that these scriptures have special powers.

Some religions limit the priesthood to certain families or classes. In other religions, dreams or other signs are used to choose priests. Many religions exclude women from the priesthood. In most cases, a person must study to enter the priesthood.

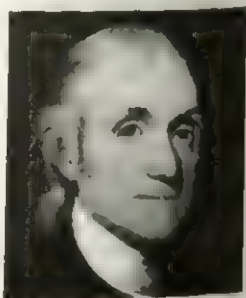
See also **Bishop; Celibacy; Minister.**

**Priestley, John Boynton** (1894-1984), was an English novelist, playwright, and journalist who wrote his novels in the realistic tradition of the 1800's. His best-known novel is *The Good Companions* (1929), an amusing story of a wandering music-hall troupe. His nostalgic novel *Lost Empires* (1965) also concerns the music-hall world. *Angel Pavement* (1930) is a more serious novel about the business world in London. Priestley wrote many nonfiction works, including *Literature and Western Man* (1960). Priestley's most popular plays include *Dangerous Corner* (1932) and *An Inspector Calls* (1945), both satires on middle-class life. *Time and the Conways* (1937) is a science-fiction play about time.

Priestley was born in Bradford, Yorkshire. After graduating from Cambridge University, he became a journalist in London in 1922.

**Priestley, Joseph** (1733-1804), an English clergyman and chemist, shares the credit for the discovery of oxygen with Carl Wilhelm Scheele of Sweden (see **Oxygen**). Priestley called the gas "dephlogisticated air." French chemist Antoine Lavoisier named it *oxygen*.

Priestley was born near Leeds, Yorkshire, and studied for the ministry. After preaching in Suffolk and Cheshire, he taught at the *dissenting* (nonconformist) academy in Warrington, Lancashire. Ordained in 1764, he became a dissenting minister in Leeds and Birmingham.



Yale University Art Gallery, Connecticut, U.S.A.

**Joseph Priestley**

At Warrington, with the aid of Benjamin Franklin and others, Priestley wrote his first scientific work, describing his experiments with electricity. Priestley turned to chemistry in the late 1760's, and he published his discovery of oxygen in 1775. Priestley also isolated and identified nitrous oxide (laughing gas) and sulphur dioxide.

Priestley's sympathies for the cause of the French Revolution made him unpopular in England. In 1791, an angry mob burned his home and chapel in Birmingham. Priestley left England and moved to the United States in 1794. He settled permanently in Northumberland, Pennsylvania, U.S.A.

**Primary colour.** See **Colour** (Methods of colour production).

**Primary election,** in the United States, is a method of selecting candidates to run for public office. In a primary election, a political party, in effect, holds an elec-

tion among its own members to select the party members who will represent it in the coming general election.

Any number of party members can run for an office in a primary. But only the winning candidate can represent the party in the general election. Parties learn from the primary votes which candidates the members of their parties prefer. When several candidates enter a primary, the winner may receive less than 50 per cent of the vote. Some U.S. states, especially in the South, then hold a *run-off primary,* in which the two candidates with the highest number of votes run against each other.

**Direct and indirect.** The *direct primary* is the most common form of primary election. In the direct primary, party members who want to run for office file petitions to have their names placed on the ballot. Voters then vote directly for the candidates of their choice. In an *indirect primary,* party members vote for delegates to party conventions, where candidates are chosen.

**Open and closed.** A primary election is considered *closed* when each voter must declare a choice of party, either when registering to vote or when voting. Party members can vote only for candidates on their party's ballot, and their party's contest is closed to members of other parties. In an *open primary,* the voter receives ballots for all the parties in the election, and chooses both party and candidates in the voting booth. A few states hold a primary called a *blanket primary,* in which voters may choose candidates from different parties.

**Nonpartisan primaries** are often used for judicial, school board, and local elections. Candidates are listed on the ballot with no indication of political affiliation. The voters choose the best candidates on the basis of their individual merits, not their party membership. The candidates with the greatest numbers of votes become the opposing candidates in the general election.

**The presidential primary** is used in over half of the U.S. states to choose delegates to the national party conventions. Each candidate who enters the election lists a slate of delegates who have promised to support the candidate at the convention. The party members show their choice for the presidential nomination by voting for the slate of delegates committed to that candidate. Primaries that select about two-thirds of the delegates are held in the first six months of presidential election years.

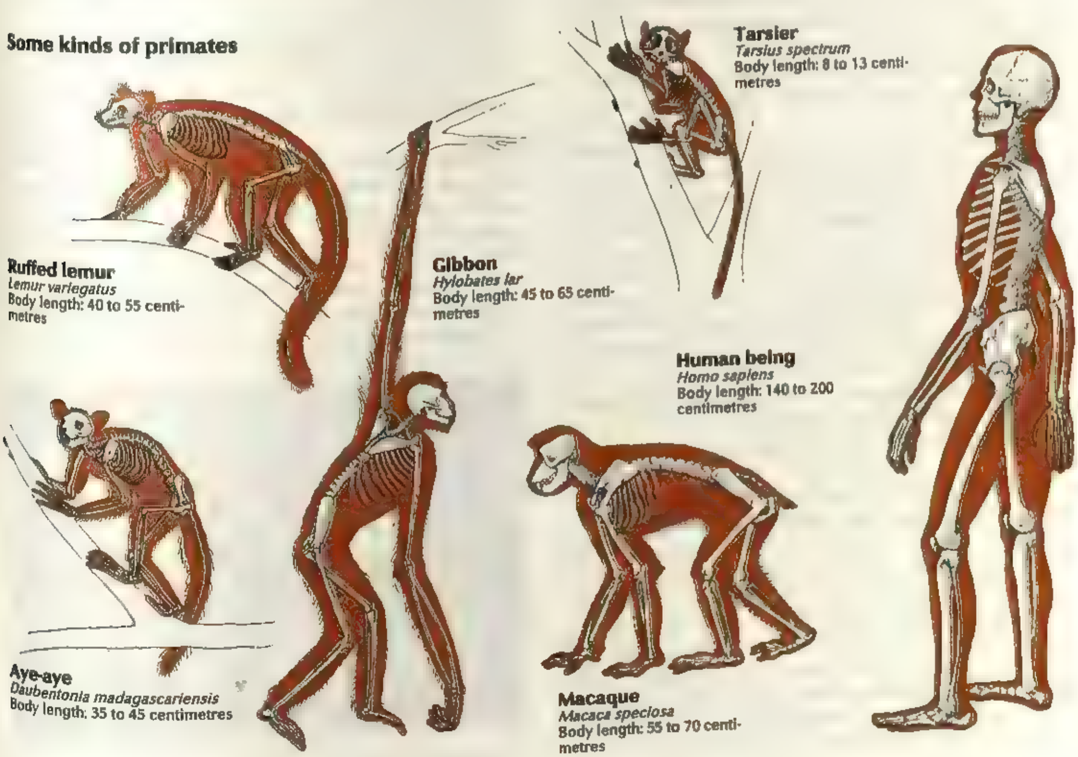
**History.** Before primary elections were used, political parties nominated candidates for office at party conventions and caucuses. Political bosses often hand-picked candidates, making shady deals to win enough votes. People gradually turned against the caucus-convention system as being undemocratic and open to corruption. Reform movements urged "No More Boss Rule" and "Down with King Caucus!"

In 1903, Wisconsin passed the first statewide primary law. Within 10 years, most states did likewise. Today, every state uses some form of primary election for statewide offices. Several states still use the caucus system to nominate presidential candidates.

See also **Caucus; Election; Preferential voting.**

**Primate** is a member of the group of mammals made up of human beings and the animals that resemble them most closely. Scientists classify about 180 species of mammals as primates. They divide the primates into two main types: (1) *anthropoids*—human beings, apes, and monkeys—and (2) *prosimians*—aye-ayes, galagos, le-

**Some kinds of primates**



murs, lorises, pottos, and tarsiers. Some scientists classify tree shrews among primates as prosimians.

**Physical characteristics.** Primates have a number of characteristic physical features, but not every primate has each of these features. The anthropoids have more of the characteristic primate features than do the prosimians. In general, the anthropoids are also larger. They have relatively large and complex brains and are more intelligent than the prosimians.

Nearly all kinds of primates can grasp objects with their hands and feet. They have nails, rather than claws, on at least some of their fingers and toes. Vision probably ranks as a primate's most important sense. Most primates have well-developed eyesight and *stereoscopic vision* (the ability to judge depth). The eyes of primates are on the front rather than on the sides of the head. Other primate features include similar skeletal structures and dental structures.

Almost all primates except human beings live chiefly in tropical or subtropical climates. Most of these animals live in trees, but some, including baboons and gorillas, spend much time on the ground. The physical features of primates are basically suited for a tree-dwelling life. For example, the ability to grasp objects helps in climbing and travelling through trees.

**Social characteristics.** Most species of primates live in social groups, but some prosimians live alone. The groups vary considerably in size and organization. Members use signals based on scent, touch, vision, and vocal sounds to communicate with one another.

Primate infants, especially baby human beings and apes, depend heavily on and learn much from their mother, including what to eat and what things to avoid.

**Human beings and the other primates.** Many of the nonhuman primates have great importance to people. For example, scientists use apes and monkeys in research on human diseases. They also study the behaviour of nonhuman primates in an effort to learn more about human behaviour.

A number of species of nonhuman primates face extinction because of people. As people clear away forests to make room for cities and farms, they destroy the home of the other primates. People also hunt some primates for food, kill others as pests, and capture many for research or to display in zoos.

**Scientific classification.** Primates make up the order Primates in the class Mammalia and the phylum Chordata. To learn where the order of the primates fits into the class of mammals, see **Mammal** (table: A classification of mammals).

See also the separate articles in *World Book* on the primates mentioned in this article.

**Prime meridian.** See **Greenwich meridian; Meridian.**

**Prime minister** is the head of the government in the United Kingdom and many other countries. The head of the state—the king or queen of a monarchy or the president of a republic—appoints the prime minister. In most countries, the head of state can appoint only the leader of the majority party in the legislature or of a coalition. The prime minister and the Cabinet are responsible to the legislature. This means that the prime minister and the Cabinet should resign if the legislature rejects a major item of their policy. This system is known as the *cabinet system* of government (see **Cabinet**).

In the United Kingdom, the prime minister is usually the leader of the party that wins an election. Usually, the monarch must abide by the prime minister's advice. The prime minister chooses the members of the Cabinet, but cannot easily ignore other important members of his or her party.

The Cabinet must agree on most government actions, but the prime minister has certain rights alone, such as asking the monarch to dissolve parliament and call an election.

Cabinet government developed in Britain during the reign of George I (1714-1727). George I took little interest in the government. Sir Robert Walpole, first lord of the treasury, came to be known as the *prime* (first) minister. The title did not become official until 1905. The British prime minister still holds the earlier title.

Under the French constitution of 1958, the head of the French Cabinet is now also called *premier* (prime minister). The premier shares power with the president of France. See **President.**

**Prime number.** See **Factor; Number theory.**

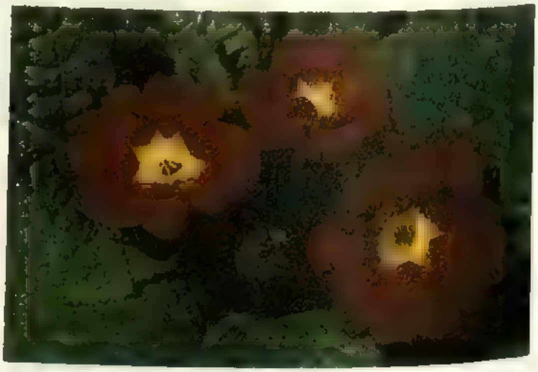
**Primo de Rivera, Miguel.** See **Spain** (The reign of Alfonso XIII).

**Primogeniture** is a system of inheritance widely used in Europe for hundreds of years. Under this system, the oldest child in a family, and often the oldest son, has the sole right to inherit land and other possessions from the parents. Primogeniture first developed under the feudal system (see **Feudalism**). The system kept the nobles' large landholdings from being broken up among their children into many small estates. It also preserved the social position and prestige of the noble families. Peasants and other landholders also practised primogeniture.

Primogeniture gradually disappeared in Europe, except among ruling families, as the feudal system died out. It came to an end in England in 1925, except for the royal family. The United States abolished primogeniture by law.

**Primrose** is the common name of a group of plants that usually flower in early spring. Cultivated primroses are considered choice ornamental garden flowers. Many of these have been developed from the *common primrose,* which grows wild in woods and meadows of Europe. Some primroses make excellent pot plants.

The common primrose has deeply veined leaves and yellowish-white flowers. Other cultivated varieties of



**Polyanthus** is a garden hybrid of the common primrose.

**Common primroses** often grow on sunny banks in woodland.

primroses have flowers that range from yellow to pink, red, lilac and purple.

Primroses grown in the garden need shade and rich, moist loam. They may be started from seed, which is planted in early spring in seed trays or boxes in a mixture of sand, loam, and leaf mould. The young plants should be set out in the open in late spring, then placed in a permanent flower bed in early autumn and protected over winter. They flower the following spring.

**Scientific classification.** Primroses belong to the primrose family, Primulaceae. The common primrose is *Primula vulgaris.* The European alpine primrose is *P. auricula.* Among the cultivated varieties are the Chinese primrose, *P. sinensis,* and the Japanese, *P. japonica.*

See also **Cowslip; Flower** (picture: Garden perennials).

**Prince** is a title of the highest rank of the nobility. The word comes from the Latin *princeps,* meaning *first. Princeps* was used as a title for civil and military officials among the ancient Romans. The German Visigoth and Lombard tribes that settled in the Roman Empire used *prince* to mean independent authority.

In modern times, the title *prince* or *princess* can be used in many ways. It is the title of the ruler of the principality of Liechtenstein. In the United Kingdom, only the eldest son of the ruler has a legal right to the title of prince, and only after the ruler has created him Prince of Wales. The oldest daughter may be granted the title Princess Royal. As a mark of courtesy, other members of the royal family, and they alone, are called prince or princess. In France, male members of the former royal Bourbon family are called prince.

**Prince consort** is the husband of a reigning queen. In countries where the daughter of a king may inherit the throne, her husband does not have the title of king.

**Prince Edward Island** (pop. 129,765) is the smallest but most densely populated province of Canada. It lies in the Gulf of St. Lawrence, a rich fishing area off the Atlantic coast of Canada (see **Canada** [political map]). Charlottetown is the province's capital and only city. The chief sources of employment and income are service industries. Agriculture is also important. Prince Edward Island has long sandy beaches, with the sea warmed by ocean currents flowing from the south.

**Prince of Wales** is the title given to the first male heir to the throne of the United Kingdom. He is always the oldest son of the sovereign, unless that son has died or given up the title. Edward I, the English king who conquered Wales in 1282, defeated Llywelyn, the last Welsh Prince of Wales. Llywelyn died in a skirmish with English troops. In 1301, Edward gave the title to his oldest son. Later, this son became king as Edward II. Since the reign of Edward II, almost all the oldest male heirs to the British throne have received it.

The title *Prince of Wales* is purely honorary. Sons of British monarchs do not inherit the title. It is newly created for each prince. The monarch's oldest son becomes *Duke of Cornwall.* Even after he is named Prince of Wales, he receives his income from the Duchy of Cornwall, in England, not from Wales. Queen Elizabeth II's son, Prince Charles, became Duke of Cornwall when his mother took the throne in 1952. His mother named him Prince of Wales in 1958, and officially presented him to the Welsh people in 1969.

See also **Charles, Prince.**

**Princes in the Tower** were the two young sons of Edward IV of England. Richard III, their uncle, imprisoned them in the Tower of London. They were Edward V (born 1470) and Richard, Duke of York (born 1473).

When Edward IV died in 1483, Edward V was too young to rule. Richard of Gloucester became guardian of the two princes and protector of England. He put the princes in the Tower of London, then claimed the throne, on the false grounds that the princes were not legitimate. They were not seen again after 1483. Richard's enemies and later Tudor historians claimed that he had the princes murdered. In 1674, the skeletons of two boys were discovered in the Tower of London.

See also **Edward (V); Richard (III).**

**Princess.** See **Prince.**

**Princess Royal** is a title bestowed by the British monarch upon his or her eldest daughter. The title has not always been conferred. During the 1900's, two women have borne it. The first was Princess Mary (1897-1965), daughter of King George V. In 1922, she married Henry Lascelles, sixth Earl of Harewood (1882-1947). Her son George Lascelles, the 7th earl, is the head of the family and has won fame as an opera-house administrator.

The present Princess Royal is Princess Anne (1950-     ), daughter of Queen Elizabeth II. Born Anne Elizabeth Alice Louise, she married a British Army officer, Captain Mark Phillips, in 1973. The couple had two children, Peter (1977-     ) and Zara (1981-     ). The marriage was dissolved in 1992. In December of that year, Princess Anne married Commander Timothy Laurence, a naval officer. Princess Anne is an enthusiastic horsewoman and took part in the showjumping in the 1972 Olympic Games. She is also president of the Save the Children Fund. She received her title of Princess Royal in 1987 in recognition of her work for this charity.

**Principal,** in economics. See **Interest** (Types of interest); **Mortgage.**

**Príncipe Island.** See **São Tomé and Príncipe.**

**Print.** See **Engraving; Japanese print; Percale; Photography** (Developing and printing); **Printing.**


**An amazing variety of printed items**—from books, magazines, and newspapers to posters, stamps, and labels for computer software—roll off printing presses every day. Almost all these items are printed by one of three basic processes: offset litho, relief, or gravure printing.

# Printing

**Printing** is one of our most important means of mass communication, along with radio, television, and films. Printing forms the basis of much of our educational system. Modern business depends on printing for everything from sales slips to money and share certificates. Advertising depends partly on printing to sell goods.

Printing and publishing are big business in many countries. In addition to books, newspapers, and magazines, thousands of other items roll off printing presses every day. These items include posters, sweet wrappers, beverage cans, calendars, ruled writing tablets, wallpaper, textiles, postcards, playing cards, mail-order catalogues, comic books, and reproductions of works of art.

Printing as we know it today began in Europe only in the 1400s. Before that time, everything people read there had to be copied by hand or printed from wood blocks carved by hand. Then one of the most influential events in history took place. About 1440, Johannes Gutenberg and his associates in Germany developed *printing with movable type.*

Movable type made from wood had been invented in China in the 1100's, and the Koreans used movable metal type in the 1200's, but the large number of characters in the Chinese language made printing with this process impractical. Gutenberg made separate pieces of metal type for each character to be printed. With movable type, a printer could quickly make many identical copies of a book. Using this process, the same pieces of type could be used over and over again—to print many different books.

Printing soon became the first means of mass communication. It put more knowledge in the hands of more people faster and more cheaply than ever before. As a result, reading and writing spread widely and rapidly.

Most commercial printing today is done by one of three processes: (1) relief printing, (2) offset lithography, or (3) gravure printing. Each of these processes uses a different kind of *image carrier* (the printing surface that carries the images to be printed). In relief printing, the printing surface is raised above the level of the nonprinting surface. In offset lithography, the printing surface and the nonprinting surface are on the same level. In gravure printing, the printing surface is below the nonprinting surface.

This article discusses the preparation of type and illustrations for printing, and describes the major commercial printing processes. The article also discusses several other printing processes and traces the history of printing. Separate *World Book* articles, such as **Bookbinding** and **Photoengraving and photolithography**, provide details on the steps in printing and publishing. Other articles, including **Engraving**, **Etching**, and **Silk-screen printing**, give information on printmaking in the fine arts.

### Preparing material for printing

In preparing text and illustrations to be printed, there are certain steps that are common to all printing processes. These steps include (1) typesetting, (2) proofing, (3) preparing illustrations for reproduction, and (4) page makeup.

**Typesetting** is the process of putting into type the words to be printed. It is also called *composition.* Typesetting can be classified as (1) hot-metal typesetting or (2) photocomposition.

***Hot-metal typesetting*** is now done mostly by machine, but until the mid-1800's, it was all done by hand. Workers called *compositors* took individual pieces of metal type from compartments in a shallow drawer called a *case.* They assembled the type piece by piece and line by line in a small tray called a *composing stick.* When the stick was full, they transferred the type to a larger tray known as a *galley.* Today, typesetting by hand is still necessary for certain *typefaces* (styles of type) and for large sizes of metal type, which cannot be set by machine.

There are two main kinds of machines that set metal type—the *line caster* and the *Monotype.* Line casters, such as the Linotype, form an entire line of type at one time. When an operator presses a key on the keyboard, a *matrix* (mould) for the corresponding character is placed in its proper position in the line of type. When all the moulds for a line are assembled, hot metal is forced into the moulds, casting the line as a single unit called a *slug.* See **Linotype.**

The Monotype casts each character as a separate unit. When a key on its keyboard is pressed, the machine punches a code of holes in a paper tape. This tape is then fed through a casting machine. The holes in the tape indicate to the casting machine which characters are required. The machine then selects the proper mould and casts each character individually. See **Monotype.**

***Photocomposition,*** also called *phototypesetting* and *filmsetting,* includes all typesetting methods that do not set metal type. Phototypesetting machines produce images of type characters on photosensitive film or paper. Phototypesetting has replaced hot-metal composition for most printing.

Most phototypesetting machines generate type images from a *fount master.* A fount master is a film negative of all the characters in a particular typeface. Light beamed through the desired character on the fount master passes through lenses to expose photosensitive film or paper. Developing the film or paper produces a positive image of the character. The lenses control magnification and can produce an image of each character on the fount master in many sizes. In hot-metal typesetting, a separate piece of type or mould is required for each character in every size.

Some phototypesetting machines produce type as the text is entered on a keyboard. Others make a coded tape similar to that of a Monotype. A computer-driven phototypesetter uses the tape to set the type. In addition, the computer *justifies* the lines—that is, it determines the proper space between words and hyphenates words when necessary to line up the right-hand margin.

Another kind of phototypesetting machine does not use a fount master. Instead, it stores information about the design of the characters in a computer memory. When a character is called for, the computer uses the information in its memory to project an image of the character onto the screen of a *cathode-ray tube,* which resembles a TV screen. The image is then focused through a lens onto a photosensitive surface which, when developed, displays a positive image of the character. This kind of phototypesetter can set a page of newspaper text in a few seconds. See **Photocomposition.**

Writers for some newspapers and magazines compose articles on a televisionlike screen called a *visual display terminal* (VDT). The VDT is connected to a computer that stores each article as it is written. Editors then can call up an article on their VDT's and make changes in it. The edited article is fed electronically to the typesetting machine, which sets the type. This process saves time and money by making it unnecessary for a person to retype the story into the typesetting machine. Some other typesetters have *optical character recognition units.* These units can read typewritten copy electronically and feed the text into a typesetter automatically.

**Proofing.** After type is set, printers make a *proof* (copy) from the type and check it for errors. Metal type is placed on a small press and inked. Paper is laid on the inked type, and a cylinder is rolled over the paper. A proof is then *pulled* (stripped off). When using photographic type, typesetters produce a proof from the film by making a photographic print.

A *proofreader* checks all proofs for accuracy. If any errors have been made, the proof goes back to the typesetter to be corrected.

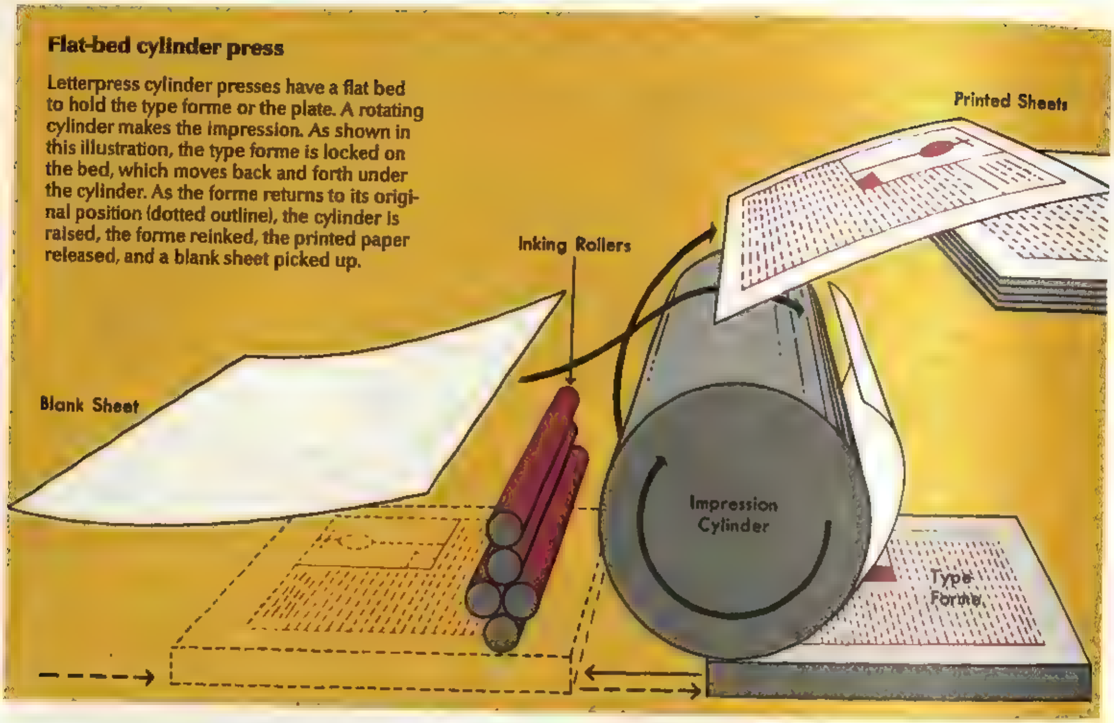
**Preparing illustrations for reproduction.** Printers use photographic processes to prepare illustrations for printing. Depending on the type of artwork to be reproduced, one of two methods is used: (1) line reproduction or (2) halftone reproduction.

***Line reproduction*** is used to copy illustrations that consist only of solid areas or lines. Such illustrations include line drawings, maps, and diagrams. The artwork is photographed using a special camera and high-contrast film, producing a negative of the desired size.

***Halftone reproduction*** is required when the illustration contains a range of tones or shades from dark to light. Such material is called *continuous tone copy* and includes paintings, photographs, and charcoal drawings. A printing press can print only solid colours, not continuous tones. The illusion of shading, however, can be created by printing artwork as a pattern of tiny solid dots. The illustration is photographed through a *halftone screen.* This screen forms an image on the negative that is composed of many tiny dots. Each dot and the space around it differ in size according to the tone of the original. When the illustration is printed, the dots blend together in the viewer's eye and appear to duplicate the shading of the original artwork. To learn how colour illustrations are printed, see the section *Printing in colour.*

**Page Makeup** involves collecting all the type and illustrations for a piece of printing. The type and illustrations are then arranged to form pages.

In relief printing from metal type, the illustrations must be made into *photoengravings.* A photoengraving




is made by placing the negative on a metal plate that has been coated with a photosensitive chemical. Light passing through the negative transfers the image to the plate. The photoengraver then *etches* the plate in an acid bath. In this process, the acid eats away the background, leaving the image area *in relief* (raised). The type and photoengravings are placed in a metal frame called a *chase*. Then this arrangement, called a *type forme,* is ready to put on the press. See **Photoengraving and photolithography.**

For most other types of printing, images of type and illustrations are made into a printing plate by a photographic process. The images may be assembled either by (1) paste-up or (2) stripping.

***Paste-up*** is the positioning of positive images on a premarked board called a *grid sheet.* The images may include halftone or line reproductions made from negatives, type set by a phototypesetter, or a proof printed from metal type. The assembled paste-up, known as a *mechanical,* is photographed to make a single negative.

***Stripping*** is the assembly of negative images of illustrations and type. The negatives are taped in their proper places to a sheet of paper. Then windows are cut out of the paper to allow light to shine through the image areas of the negatives. This arrangement, known as a *flat,* is used in making a printing plate.

### Printing by relief

In relief printing, ink is transferred by means of a raised printing surface. Relief is the oldest method of printing. More than a thousand years ago, the Chinese printed from wood blocks. They carved the nonprinting areas from the surface of a piece of wood, leaving characters and designs in relief. Then they inked the raised surface. They placed a sheet of paper on the block and transferred the ink to the paper by rubbing the back of the sheet. See **Block printing.**

Another kind of relief printing is called *letterpress printing.* In letterpress printing, a printing press is used to make printed images from type formes or from relief printing plates.

**Relief printing plates.** Originally, all letterpress printing used type formes containing metal type and carved blocks or photoengravings. Today, however, much relief printing uses printing plates made photographically. These plates offer several advantages over type formes. First, the plates can be made from cold type as well as hot-metal type. In addition, many identical plates can be made at the same time photographically. Furthermore, one kind of press, the rotary press, cannot print from type formes. It requires the printing surface to be fastened to a cylinder. Flexible relief printing plates, unlike type formes, can be curved to fit the cylinder.

Nearly all relief printing plates are made of photosensitive plastic on a metal base. When a negative is exposed to the plastic, the plastic hardens in the image areas. The nonimage areas remain soft and can be removed with water, caustic solution, or a blast of air. Removing these areas leaves the image areas in relief. The plate is then hardened further before printing.

**Relief presses.** The plates or type formes go to the *pressroom* of the printing plant. Here, amid the thumping and whirring of the presses and the smell of ink, the actual printing is done. The main job of a press is to transfer ink from the printing surface to the paper. But most presses do much more. They can pick up the blank paper, move it through the press, print on both sides of the paper in one or more colours, and cut the printed paper and fold it into pages.

The presses used for letterpress printing vary in size and design. They are usually divided into three groups: (1) platen presses, (2) flat-bed cylinder presses, and (3) rotary presses.

***Platen presses*** use two flat surfaces to print. One surface is the *bed.* It holds the type forme or plate. The other surface is a metal plate called the *platen.* It holds the paper or other material to be printed. Most platen presses run automatically. Rollers ink the forme or plate as a sheet of paper is fed to the platen. The platen then swings against the printing surface and prints the sheet as the rollers roll back to an inking plate. As the platen swings back, the printed sheet is released.

Platen presses are widely used for printing handbills, programmes, and similar items. Such printing is called *jobbing printing.*

***Flat-bed cylinder presses,*** also known as *cylinder presses,* have a flat bed to hold the plate or type forme. A heavy rotating cylinder makes the impression. The bed moves back and forth under the impression cylinder. As the cylinder turns, it picks up a sheet of paper. The cylinder rolls the paper over the plate or forme as the bed passes under it. Then, as the bed returns to its original position, the cylinder lifts, rollers ink the printing surface, and the printed sheet is released.

Cylinder presses can be *vertical* or *horizontal.* That is, the bed can move up and down against the cylinder or back and forth under it. A *perfecting* cylinder press prints both sides of the paper. It has two flat beds and two cylinders. Flat-bed presses are used to print books, cartons, pamphlets, and many other items.

***Rotary presses*** are used for the mass production of newspapers, magazines, and books. These presses have cylinders both to make the impression and to hold the plates. The paper is printed as it passes between the impression cylinder and the plate cylinder.

A rotary press operates with a *unit system* or a *common impression system.* In a unit system, each plate cylinder has its own impression cylinder. Each of these units has a separate inking system. The number of units determines the number of colours to be printed. For example, two units print two colours, and four units print four colours. A common impression system uses only one impression cylinder, but up to five plate cylinders may be grouped around it. Each plate cylinder has its own inking system.

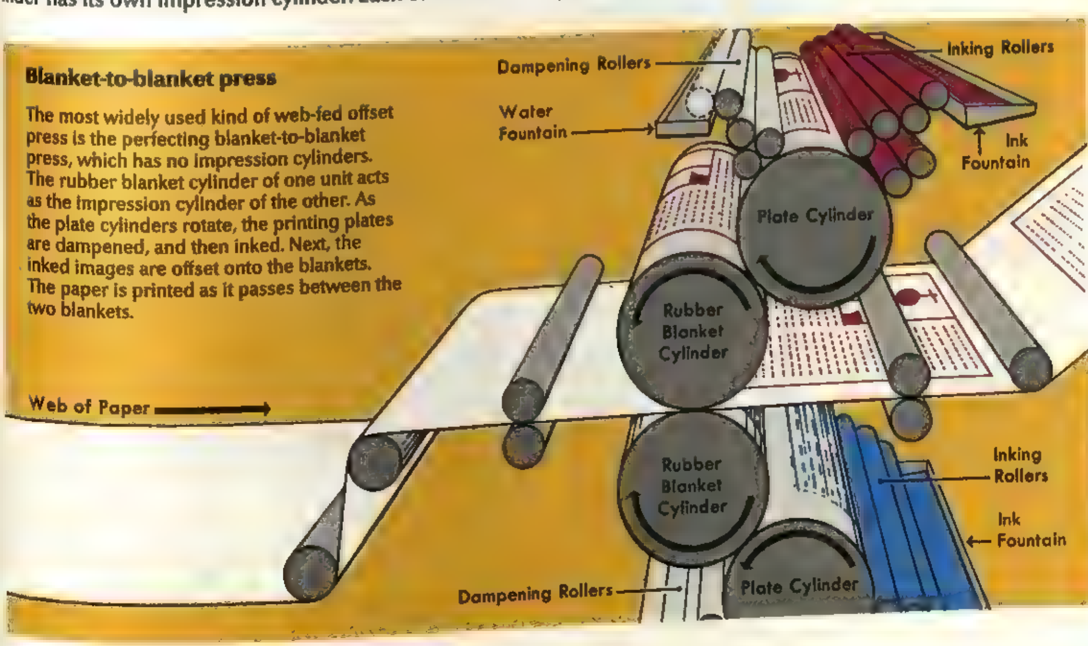
Rotary presses can be either *sheet-fed* or *web-fed.* Sheet-fed presses print single sheets of paper. Web-fed presses print from a huge roll of paper. The paper passes between the cylinders in a continuous sheet called a *web.* A device on the press cuts the printed paper into smaller sheets and folds them into pages for a newspaper, magazine, or book. All web-fed rotaries are perfecting presses.

After the printers set up a press, they print some sample copies. Then, in a process called *makeready,* they make various adjustments to get the best possible impression. They paste pieces of paper on the impression surface or under the printing plate to build up areas that print too lightly. In places where the impression is too heavy, they cut away some of the layers of paper, called *packing,* that cover the impression surface.

### Printing by offset lithography

Lithography is a method of printing from a flat surface. It is based on the fact that grease and water do not mix. Alois Senefelder, a German writer trying to print his own work, discovered lithography in 1798. He drew a design on a stone with a greasy crayon. Then he dampened the stone, and the water stuck only to the parts not covered by the design. Next, he inked the stone, and the greasy ink stuck only to the design. Senefelder then pressed paper against the stone, and transferred the image to the paper.

Today, the same principle is used in commercial printing. Thin metal plates have replaced the stone, and the images are put on the plates photographically. The printing press does not transfer the inked images di-



rectly from the plates to the paper. Instead, the press first *offsets* (transfers) the images onto a rubber-covered cylinder, which then offsets them onto the paper or other material to be printed.

Offset lithography is the most commonly used printing process. It is used to print books, magazines, stationery, metal containers, cartons, labels, and many other items. The process is often called simply *litho.* It is also known as *planography,* because the printing is done from a *plane* (flat) surface.

**Offset printing plates** are made by a process called *photolithography.* They are produced photographically from paste-ups or flats. The negatives of the paste-ups or flats are held by vacuum pressure against a metal plate that has a light-sensitive coating. Light from high-intensity lamps shines through the negatives and hardens the image area on the plate. Then the plate is treated with lacquer that adheres only to the image areas. Excess lacquer is washed off and the nonimage areas are gummed to increase their ability to hold water. During printing, only the lacquered image areas accept ink. See **Photoengraving and photolithography.**

**Offset presses** are rotary presses. The printing plate is clamped to the plate cylinder. As the cylinder rotates, it presses against damping rollers, which dampen the plate so the nonprinting areas will repel ink. The cylinder next passes against ink rollers. The greasy ink sticks only to the image areas. The turning plate cylinder then offsets the inked images onto a rubber *blanket* cylinder. The rotating blanket cylinder, in turn, offsets the images onto the paper carried by the impression cylinder.

Offset presses have a unit system. Some presses print only black or any other single colour. Others print two, four, or more colours. A few sheet-fed presses are perfecting presses.

Most web-fed offset presses are multicolour perfecting presses. The most popular web offset press is the perfecting *blanket-to-blanket* press. This press has no impression cylinders. The web passes between the two blanket cylinders of two units. The blanket cylinder of one unit serves as the impression cylinder for the other. The paper is printed on both sides as it goes between the blankets. The printed paper can be delivered on another roll. Or the paper can be cut into sheets and piled, or it can be cut and folded into groups of pages called *signatures* or *sections.*

*World Book* is printed on web offset presses. These presses can produce 17,000 *World Book* signatures an hour. The presses can use a 9-kilometre roll of paper every 30 minutes as the web speeds through at about 300 metres per minute. For more information on offset printing, see **Offset.**

### Printing by gravure

Gravure is an *intaglio* method of printing. That is, the words, pictures, or designs to be printed are sunk into the printing plate or cylinder. For hundreds of years, artists have used the intaglio principle to make engravings. They use sharp-pointed tools to cut a picture into a metal plate. They then cover the plate with ink and wipe it clean. The ink remains only in the sunken lines of the picture. When paper is pressed against the plate and into the lines, the inked image is transferred to the paper.

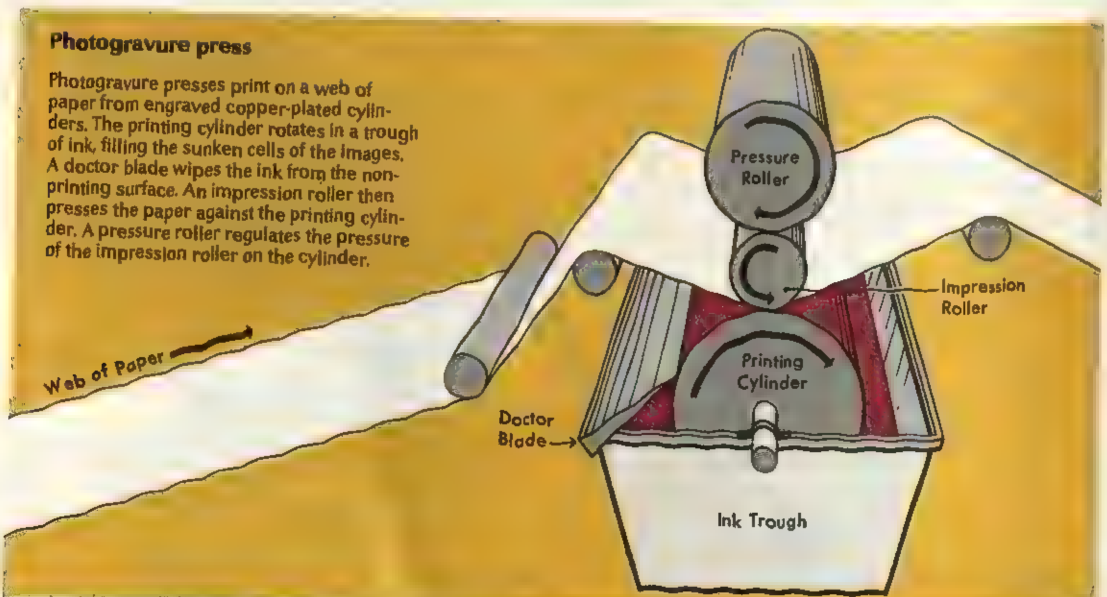
Commercial gravure works in a similar way, but the images are put on the printing plate or cylinder by a photographic process. Then acid is used to cut the images into the plate.

Gravure is used to print the magazine sections of newspapers, and also wedding invitations, calling cards, mail-order catalogues, food and sweet wrappers, paper money, postage stamps, share certificates and bonds, wallpaper, and many other items.

**Gravure printing plates and cylinders.** Gravure printing is done from engraved plates or cylinders. They are made by a process similar to photoengraving. All the copy is photographed. But tone copy, such as photographs and paintings, is not photographed through a

**Photogravure press**

Photogravure presses print on a web of paper from engraved copper-plated cylinders. The printing cylinder rotates in a trough of ink, filling the sunken cells of the images. A doctor blade wipes the ink from the nonprinting surface. An impression roller then presses the paper against the printing cylinder. A pressure roller regulates the pressure of the impression roller on the cylinder.



screen, as it is for relief and offset printing. After the negatives have been made, film positives are made from them. The positives are then pasted up as they are to appear in print. Next, the images on the positives are transferred to the printing surface through the use of *carbon tissue,* a sheet of paper covered with light-sensitive gelatin. The carbon tissue is first exposed under bright light to a screen. Then it is exposed to the film positives. The gelatin hardens according to how much light passes through the positives. The lightest areas on the positives allow the most light to pass through. The gelatin is hardest and thickest in these areas.

The exposed tissue is placed gelatin side down on a thin, flexible copper plate or heavy copper-plated cylinder. The tissue is developed in water, and the paper backing is stripped off. A layer of gelatin containing thousands of little gelatin squares of varying thickness is left standing on the copper. The plate or cylinder is then bathed in a corrosive solution. The solution eats through the gelatin squares, and bites thousands of little *cells* (pits) into the copper. It penetrates the thinnest squares fastest, and bites deepest in these areas. On the printing press, the deepest cells hold the most ink and print the darkest tones. The shallowest cells hold the least ink and print the lightest tones.

There are also several other gravure platemaking processes. Some processes do not use carbon tissue. Instead, a light-sensitive coating is applied directly to the printing plate or cylinder. Other processes produce cells that differ in size as well as in depth in order to create clearer, sharper tones. For more information on gravure platemaking, see **Photoengraving and photolithography.**

**Gravure presses** are either sheet-fed or web-fed rotary presses. Sheet-fed presses print from engraved copper plates, which are clamped around the plate cylinder. Web-fed presses print from engraved copper-plated cylinders, which are positioned on the press. Web-fed gravure presses, called *photogravure* presses, can run at speeds of more than 300 metres per minute.

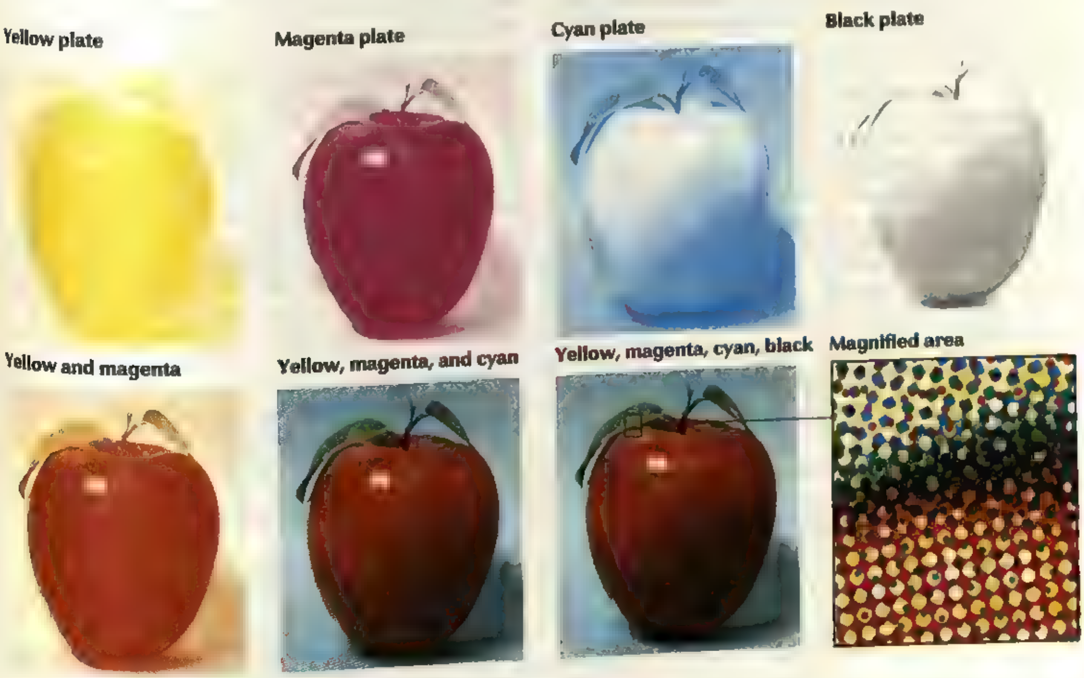
On a gravure press, several methods can be used to ink the printing cylinder. Most presses use a trough of ink. As the cylinder rotates, it dips into the trough, filling the cells with ink. A *doctor blade* wipes the surface clean, so that ink remains only in the cells. The impression roller then presses paper against the printing cylinder and into the cells. The pressure transfers the ink in each cell to the paper.

## Printing in colour

Relief printing, lithography, and gravure can reproduce anything in colour—from comic strips to masterworks of art. There are two chief kinds of colour printing: (1) *process colour printing* and (2) *flat colour printing.*

**Process colour printing** is used mainly to reproduce colour copy that contains shades or tones. Such copy includes oil paintings, watercolours, and colour photographs. By using only tiny dots of transparent ink in the colours yellow, magenta (a purplish red), and cyan

**Printing with process colours** To reproduce a colour picture, printers usually make four printing plates—one each to print yellow, magenta, cyan, and black ink. In reproducing the picture of the apple, printers first printed the yellow plate. Then they printed the magenta plate, producing a picture made up only of yellow and magenta tones. Printing the cyan plate next made a picture of yellow, magenta, and cyan tones. The black plate was then printed to add sharpness and contrast to the picture. The magnified area shows how the colours of all the plates combine to form the tones of the picture.



(a blue), process colour printing can reproduce copy containing almost any colour and tone.

Three printing plates must be made—one each to print yellow, magenta, and cyan ink. Usually, a black plate is also made, because black ink adds sharpness and contrast to the printed illustration.

The first step in making colour plates is to separate the colours in the copy photographically. A camera photographs the copy four times to get a *separation negative* of the yellow, magenta, cyan, and black in the copy. Each time, a different coloured filter is used to block out all colours from each negative except the desired colour. Today, colour separations are usually created on an *electronic colour scanner,* a device that scans the copy with a small light beam, and produces colour separation negatives quickly and automatically.

For relief and offset printing, the photographer also shoots the copy through a halftone screen to get the dot pattern. The screen is placed at a different angle for each colour. In printing, some of the tiny dots fall close together, some overlap, and some fall on top of others. When viewing the resulting image, the eye mixes the colours of the dots on the printed page into all the colours and shades of the original copy. For example, what the eye sees as green is really an area of tiny cyan and yellow dots.

An *indirect screening* process is also used. In this method, the photographer shoots the copy through the different coloured filters, but not through a halftone screen. Then the unscreened negatives are rephotographed to produce positives. Finally, the positives are shot through a screen to make the halftone negatives. Gravure process colour printing also uses a screen, but it is printed on the carbon tissue.

After the separation negatives have been made, the steps follow the regular procedures for making relief or offset plates, or gravure plates and cylinders. On a four-colour rotary press, each plate has its own supply of yellow, magenta, cyan, or black ink. The paper passes from one set of cylinders to the next, picking up the different colours and emerging from the press fully printed. Usually, only yellow, magenta, cyan, and black inks are used on the presses. Sometimes, colours other than these are used to achieve special effects.

**Flat colour printing** is used chiefly to print *line copy* in solid colours. Such copy includes diagrams, headlines and other type matter, cartoons and comic strips, and trademarks on stationery. Flat colour printing is simpler than process colour printing. Separate plates must be made for each colour of opaque ink, but halftone dots are not used to create tones or other colours in flat colour printing.

### Other printing processes

In addition to relief printing, offset lithography, and gravure, there are many other printing processes. The most important ones include *screen process, collotype,* and *flexographic* printing.

**Screen process printing** requires a stencil and a fine cloth or wire screen. The stencil carries the design to be printed. It can be made simply by cutting the design out of paper. The stencil is mounted against the screen. Ink is squeezed through the stencil onto the surface to be printed. The design can also be traced directly on the screen, and the nonprinting parts painted out. Or the screen can be given a light-sensitive coating and the design put on it photographically.

Screen process can be used to print on paper, glass, cloth, wood, or almost any other material. It is used to print on objects of almost all sizes and shapes, including draperies, banners, bottles, toys, and furniture. Most screen process printing is done on automatic or hand-operated presses. Screen process is also called *silk-screen printing* (see **Silk-screen printing**).

**Collotype printing** is similar to lithography. A light-sensitive coating of gelatin is put on a metal or glass plate. The gelatin is exposed to light under an unscreened negative that carries the image to be printed. The light passes through the negative, hardening the gelatin to varying degrees. The plate is then soaked in a solution of water and glycerin. The hardest parts of the gelatin absorb the least solution, and the softest parts absorb the most. On the printing press, the hardest, driest parts accept the most ink and print the darkest tones. The softest, wettest parts accept the least ink and print the lightest tones.

Collotype is mainly used to print high-quality reproductions of paintings. The process is sometimes called *photogelatin printing.*

**Flexographic printing,** also called *flexography,* is a specialized form of relief printing that uses rubber plates. Because the inks used in flexography dry very quickly, this process is suitable for printing on a wide variety of nonabsorbent surfaces, such as plastic and foil. The soft rubber plates are well suited for printing on thick surfaces, such as cardboard. Flexographic printing is used in the packaging industry for printing plastic bags and cardboard boxes.

Flexographic plates can be made from metal type formes or plastic relief plates from photocomposition originals. The type forme or plate is pressed into cardboard or soft plastic, leaving a negative relief of the image. The negative relief is then used as a mould, or *mat,* to form the rubber plate. A sheet of rubber is pressed into the mould and hardens when heated, forming a positive relief plate. Flexographic plates are mounted on the plate cylinder of special rotary presses for printing. Rubber plates are exceptionally durable and can be used for high speed printing and long press runs.

### History

The history of printing can be traced back thousands of years, to when people first learned to press carved designs into wet clay. About A.D. 105, Cai Lun (also spelled Ts'ai Lun) invented paper in China. The Chinese probably also invented *block printing.* They carved characters and pictures on wood blocks, inked the raised images, and transferred the ink to paper. Yet printing as we know it today has a short history. Modern printing began only about 500 years ago with the first practical use of movable type by Johannes Gutenberg and his associates in Germany.

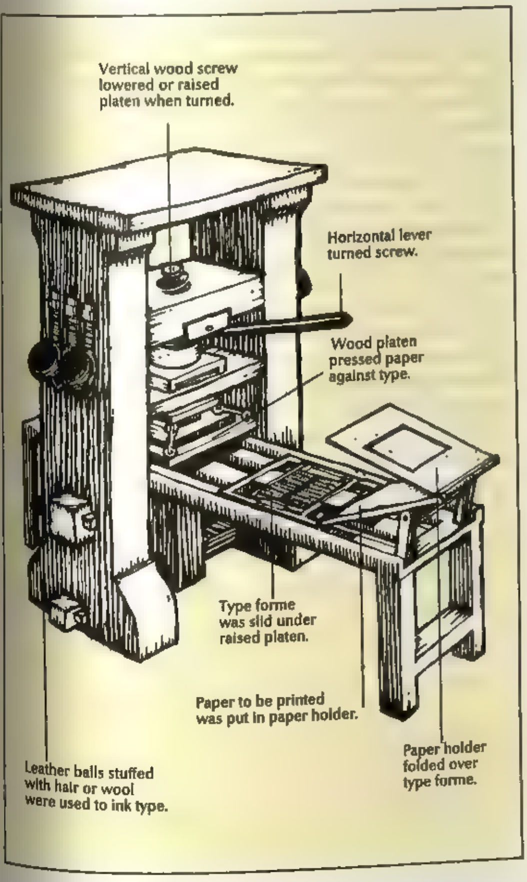
**The invention of movable type.** About 1045, a Chinese printer named Bi Sheng (Pi Sheng) made the first movable type. He made a separate piece of clay type for each character. The use of movable type did not develop in China because the Chinese language has thou-

sands of different characters. Printers would have had to make too many pieces of type. They found it easier to print from wood blocks.

While the people of the Orient were printing from wood blocks, the people of Europe were still producing handwritten books. Many monks spent their lives laboriously copying books with quills and reeds. In the late 1300's, Europeans discovered block printing. The earliest dated European wood block print is a picture of Saint Christopher, printed in 1423. About this same time, Europeans began to produce *block books* by binding prints together.

Meanwhile, the Renaissance was sweeping through Europe. The great desire for learning created a huge demand for books that hand copying and block printing could not satisfy. Movable type provided the solution to the problem.

Johannes Gutenberg and his associates began using separate pieces of raised metal type in about 1440. Gutenberg developed a printing press from a machine used to press grapes or cheese. He assembled his pieces of type in a forme, and then inked the type. Next, he placed paper on the type. Then, by turning a huge wood screw on the press, he brought down a wood block against the paper. The Gutenberg press could print about 300 copies a day. By 1456, the famous 42-line Gutenberg Bible was completed. Each column had 42 lines of type. See **Gutenberg, Johannes.**




**Gutenberg's press** probably looked like this drawing. It was adapted from a cheese or wine press and could print about 300 sheets a day. It produced the magnificent Gutenberg Bible.

Many people feared that the new art of printing was a "black" art that came from Satan. They could not understand how books could be produced so quickly, or how all copies could look exactly alike. In spite of people's fears, printing spread rapidly. By 1500, there were more than 1,000 print shops in Europe, and several million books had been produced.

**New presses and typecasting machines.** The printing press changed little from Gutenberg's time until the 1800's. An English nobleman, the Earl of Stanhope, built the first all-iron press in about 1800. In 1811, Friedrich Koenig of Germany invented a steam-powered cylinder press. This press used a revolving cylinder that pressed the paper against a flat bed of type. *The Times* of London used a steam-powered press, with two revolving cylinders, for the first time in 1814. It could print 1,100 sheets per hour.

In 1846, Richard Hoe, an American, invented the rotary press. He attached type to a revolving cylinder, and used another cylinder to make the impression. The first Hoe presses printed 8,000 sheets per hour. Later models turned out 20,000 sheets per hour. In 1865, William Bullock, an American, found a way to print from a continuous roll of paper, and invented the high-speed web-fed rotary press.

Until the 1880's, printers had set all type by hand, just as Gutenberg had done over 400 years before. In 1884, Ottmar Mergenthaler, a German living in the United States, patented the Linotype (see **Mergenthaler, Ottmar**). This machine, which casts a full line of type in one piece of metal, made typesetting more efficient. In 1887, Tolbert Lanston, an American, invented the Monotype, which casts and sets separate pieces of type.

**Developments in platemaking.** In 1826, Joseph Nicéphore Niépce, a French physicist, produced the world's first photograph. This achievement, and further developments in photography, made possible photo-engraving, the halftone process, and photolithography and modern offset printing.

In 1852, W. H. Fox Talbot of England patented photo-engraving. Two Americans, Max and Louis Levy, perfected the halftone screen in the 1880's. Alphonse Louis Poitevin of France invented photolithography in 1855. By the late 1800's, offset presses appeared in Europe. These early presses were used to print tin sheets for making cans and boxes.

About 1905, Ira Rubel, an American papermaker and printer, accidentally discovered the offset method for printing on paper. While running his press, Rubel unintentionally transferred the inked images onto the rubber-covered impression cylinder, instead of onto paper. Then, when he ran paper through the press, the impression cylinder offset the images onto the paper. Rubel noticed that the offset images were unusually sharp. Improvements in the offset press followed, and offset printing quickly came into general use.

Since the 1930's, more advances have been made in printing than in all the years since Gutenberg. The printing industry today is being changed through such developments as photocomposition, computerized typesetting, and electronic colour scanners.

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**Outline**

**I. Preparing material for printing**
A. Typesetting
B. Proofing
C. Preparing illustrations for reproduction
D. Image assembly

**II. Printing by relief**
A. Relief printing plates
B. Relief presses

**III. Printing by offset lithography**
A. Offset printing plates
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**IV. Printing by gravure**
A. Gravure printing plates and cylinders
B. Gravure presses

**V. Printing in colour**
A. Process colour printing
B. Flat colour printing

**VI. Other printing processes**
A. Screen process printing
B. Collotype printing
C. Flexographic printing

**VII. History**

**Questions**

Why was the invention of movable type one of the most important events in all history?
What are the three major printing processes? How do they differ?
What is the difference between hot type and cold type?
What is the difference between the Linotype and the Monotype?
Why was the development of photography so important in the history of printing?
Although the Chinese invented movable type, they did not develop its use. Why?
How are *separation negatives* produced for colour printing?
How did Ira Rubel discover the offset method for printing on paper?

**Prío Socarrás, Carlos.** See **Cuba** (The Batista era).

**Prion,** also called *whalebird,* is any of six species of sea birds. Prions are found in the Southern Hemisphere. They grow up to about 30 centimetres in length and are blue-grey above with white underparts. They have a dark "W" shaped marking on the wing.

Prions are usually seen in large flocks, flying quickly over the surface of the water. They catch plankton and other small creatures on which they feed. Small organisms such as plankton are filtered out by *lamellae* (plates) on the bill. In summer, prions form breeding colonies on islands in the southern oceans. The fairy prion nests on islands off the coast of Australia.

**Scientific classification.** Prions belong to the petrel family, Procellariidae. The fairy prion is *Pachyptila turtur.*

**Prion** is a microscopic particle that causes *scrapie,* a disease of sheep and goats. Scrapie attacks and gradually destroys the central nervous system of the animal. It is usually fatal.

The structure of prions has yet to be fully determined. Scientists believe that prions might lack nucleic acid, the chemical compound that occurs in the cells of all living things that have been studied. Research has shown that prions are at least partly composed of protein. In scrapie, an excess of the prion protein in the animal's tissues disrupts normal cell activities and functioning of the nervous system. However, it is not known how the protein causes these abnormalities.

Scientists believe that prions also cause certain diseases of the central nervous system in human beings. For example, prions have been suggested as a possible cause of Alzheimer's disease, a brain disorder common among elderly people (see **Alzheimer's disease**).

**Prior, James** (1927- ), a British Conservative politician, served from 1981 to 1984 as secretary of state for Northern Ireland. Previously he was secretary of state for employment from 1979 to 1981.

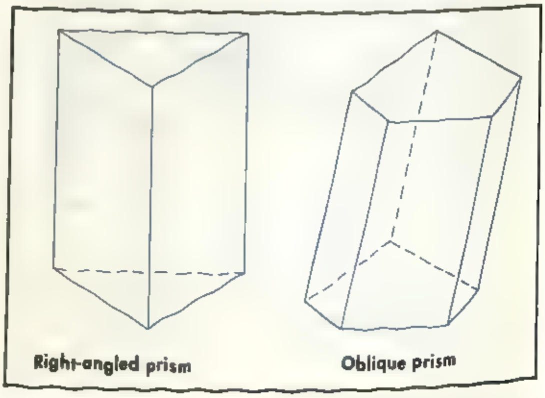
Prior was born in Norwich, England. His full name is James Michael Leathes Prior. He was educated at Charterhouse and Cambridge University. He was a member of Parliament from 1959 until 1987. From 1965 to 1970, he was parliamentary private secretary to Edward Heath. From 1970 to 1974, Prior served first as minister of agriculture, fisheries, and food (1970-1972), and then as lord president of the council (1972-1974).

**Priories.** See **Monasteries.**

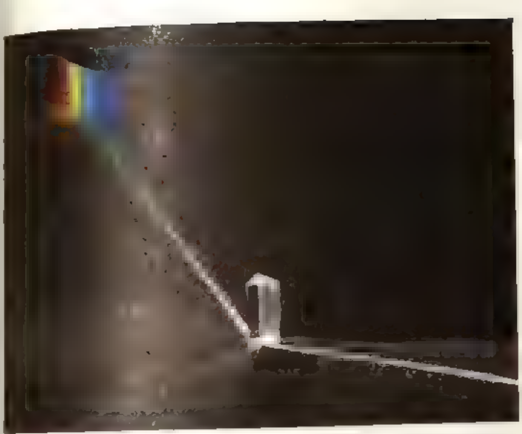
**Prism** is a solid that has two parallel bases joined by three or more *lateral surfaces* (sides). The bases are polygons that have the same size and shape. The lateral surfaces are parallelograms.

There are many types of prisms. The simplest has triangular bases. In a *right-angled prism,* the lateral surfaces are perpendicular to the bases. Prisms that do not have this property are called *oblique prisms.*

Prisms form an important class of optical elements. Prisms made of glass or quartz are used in a variety of instruments to change the direction of a beam of light. Periscopes contain right-angled prisms that reflect




**Types of prisms** include right-angled prisms and oblique prisms, *above.* The sides of a right-angled prism are perpendicular to its bases. The oblique prism's sides and bases are not perpendicular.



A prism splits a beam of white light, *lower right,* into a band of colours called a *spectrum, upper left.* The light ray on the lower left is a reflection of the original beam.

light at a right angle to its original direction. In binoculars, the direction of the light is reversed after the light is reflected off two sides of the prism.

Prisms also can change the direction of a beam of light by means of *refraction*—that is, they can bend the light as it passes through them. The angle at which light is refracted depends on its wavelength. Different colours of light have different wavelengths. If a beam of white light, which contains all the wavelengths of visible light, passes through a prism, it is split up to form a band of colours called a *spectrum.* For this reason, prisms are an important part of spectrometers and other instruments that are used to measure the spectral composition of light.

See also **Binoculars** (diagram); **Colour** (The relation between colour and light; diagram); **Light; Polygon; Refraction; Spectrometer.**

**Prison** is an institution for confining and punishing people who have been convicted of committing a crime. Prisons punish criminals by severely restricting their freedom. For example, prisons limit where *inmates* (prisoners) may go, what they may do, and with whom they may associate. Inmates serve prison sentences ranging from less than a year to the rest of their lives. Prisons are also important because they help protect society from its most dangerous criminals.

### Types of prisons

There are various types of institutions that confine convicted lawbreakers or persons awaiting trial. They may be known as *penitentiaries, reformatories,* or *correctional centres,* as well as prisons or *jails.* In the United States, a jail generally refers to a local prison holding people convicted of less serious crimes or awaiting trial. Many people consider prisons to be only those institutions that confine adults convicted of major crimes. Institutions for young offenders include youth custody centres and detention centres. In addition, specially built remand centres, separate from prisons, hold people who are awaiting trial.

Women form a small proportion of all inmates in prisons. Most of them are held in prisons that house only women.

Experts classify prisons by the degree of security or control they provide. The main types are (1) maximum security prisons, (2) medium security prisons, and (3) minimum security or open prisons.

**Maximum security prisons** generally hold prisoners serving long sentences. These prisoners have committed murder, robbery, kidnapping, treason, or other very serious crimes.

High stone walls or strong chain fences surround most maximum security prisons. Many of these barriers have electronic detection devices and powerful spotlights. Prisoners live in cells and eat either in their cells or in a dining hall. Prison officials limit the length and number of visits by family and friends. During such visits, thick glass or wire screens separate some prisoners and visitors to prevent the exchange of such prohibited items as drugs and weapons. Other prisoners and visitors are allowed to be together. Some prisons use X-ray devices to check visitors for hidden weapons.

**Medium security prisons** hold inmates who have committed less serious crimes, such as minor assaults and small thefts. The inmates in medium security prisons are generally less dangerous than those in maximum security prisons.

Medium security prisons may be surrounded by fences with guard towers. Some have educational and athletic facilities similar to those at schools.

**Minimum security or open prisons** are the least restrictive prisons. Inmates of minimum security prisons are not considered dangerous and are unlikely to flee prison. Many of these inmates were convicted of such nonviolent crimes as business theft, forgery, obstruction of justice, and perjury. They live in comfortable rooms and usually may move about within the prison as they please. Minimum security prisons range from large institutions to small farm or forestry camps.

**Juvenile correctional centres** generally hold offenders under the age of 18. The institutions keep young prisoners away from the bad influence of dangerous adult criminals. Remand centres hold young people who have been accused of committing crimes and are awaiting trial. Detention centres, or youth custody centres, are institutions where convicted youths serve their sentences. Most of these sentences last about a year. The centres offer counselling, education, job training, and recreation.

### How prisons operate

Prisons have four major purposes. These purposes are (1) retribution, (2) incapacitation, (3) deterrence, and (4) rehabilitation. *Retribution* means punishment for crimes against society. Depriving criminals of their freedom is a way of making them pay a debt to society for their crimes. *Incapacitation* refers to the removal of criminals from society so they can no longer harm innocent people. *Deterrence* means the prevention of future crime. It is hoped that prisons provide warnings to people thinking about committing crimes, and that the possibility of going to prison will discourage people from breaking the law. *Rehabilitation* refers to activities designed to change criminals into law-abiding citizens, and may include providing educational courses in prison, teaching job skills, and offering counselling with a psychologist or social worker.

**Prisoners** in a women's prison make clothes in the prison's machine shop, *above.* Many prisoners have the opportunity to work while serving their sentences.

The four major purposes of prisons have not been stressed equally through the years. As a result, prisons differ in the makeup of their staffs, the design of their buildings, and their operations.

**The prison staff** is headed by a governor, who directs the operation of the prison. This official is held responsible if there are such problems as riots, escapes, prison mismanagement, and brutality toward prisoners.

Prison warders observe and supervise the inmates. Many prison warders take an examination to qualify for their jobs. Most prison warders receive little or no special training after they are first employed. Many prison staffs also include teachers, social workers, psychologists, and doctors and nurses.

**Prison buildings** vary greatly in design. Prisons built in the *radial design* resemble the hub and spokes of a wheel. The cells, dining hall, and other facilities extend from the control centre at the hub. Warders at the control centre can observe all activity within the building. Some maximum security prisons use a different design consisting of a long corridor crossed by shorter corridors that hold the cells and other facilities. Prisoners must use the central corridor when they move from place to place. This design allows close supervision by the warders. The *high-rise design* is a *vertical* (up and down) version of the corridor design. Prisoners move from floor to floor by lift. Juvenile institutions and open prisons often consist of a group of buildings surrounding a central square. The buildings may include a library, chapel, dining hall, and classrooms.

**Prison cells** are generally small and simply furnished. Some may contain only a bed, table and chair. Modern prison cells have their own toilets and washbasins. However, many old prisons still in use today have no modern sanitary facilities, so prisoners may have to use buckets when confined to their cells. Prisoners who are hard to control may be placed for a time in a *segregation cell* (solitary confinement). Most segregation cells have dim lighting, poor ventilation, and inadequate sanitary facilities. Segregation cells may have only a mattress on the floor or a stone slab on which the prisoner sleeps.

**Special facilities and services** may be provided for inmates, depending on the views of prison officials and the availability of funds. Prisons may have libraries and athletic facilities for the use of inmates. Prisons may offer counselling, medical care, television, films, and religious services. Some prisons offer courses for examinations, or provide job training in such fields as car repair and carpentry.

Some prisons operate their own farms or factories and use inmates as workers. Some of these prisons pay inmates for their labour. By providing goods for the prisoners' use, prison farms and factories help prisons reduce their operating costs. Some prisons run *work-release programmes,* in which trusted inmates may leave prison during the day for an outside job.

## History

**Early prisons.** Before the 1700's, governments seldom imprisoned criminals for punishment. Instead, people were imprisoned while awaiting trial or punishment. Common punishments at that time included branding, imposing fines, whipping, and *capital punishment* (execution). The authorities punished most offenders in public in order to discourage people from breaking the law. Some criminals were punished by being made to row the oars on ships called *galleys.*

However, English and French rulers kept their political enemies in such prisons as the Tower of London and the Bastille in Paris. In addition, people who owed money were held in *debtors' prisons.* In many such cases, offenders' families could stay with them and come and go as they pleased. But the debtors had to stay in prison until their debts were settled.

During the 1700's, many people criticized the use of executions and other harsh punishments. These critics included the British judge Sir William Blackstone. As a result, governments turned more and more to imprisonment as a form of punishment.

**Early prison reform.** Early prisons were dark, dirty, and overcrowded. They locked all types of prisoners together, including men, women, and children, plus dangerous criminals, debtors, and the insane. During the late 1700's, the British reformer John Howard toured Europe to observe prison conditions. His book *The State of the Prisons in England and Wales* (1777) influenced the passage of a law that led to the construction of the first British prisons designed partly for reform. These prisons attempted to make their inmates feel *penitent* (sorry for doing wrong) and became known as *penitentiaries.*

One form of imprisonment was transportation to a penal colony. During the 1700's, British convicts were sent to North America to work in cotton fields. This ceased in 1776, when the United States achieved independence. After 1789, convicts were sent to Australia.

The first convicts were sent to work as servants. If they misbehaved, the government took them back and put them in chain gangs to break stones and build roads. Eventually purpose-built penal colonies were established, such as the one at Port Arthur, Van Diemen's Land (now Tasmania), founded in 1833.

At the beginning of the 1800's, prison reformers began to emphasize the importance of keeping prisoners alone. It was thought that if they had time to reflect in solitary confinement, prisoners would see the error of their ways and become reformed. Prisons were built consisting of many tiny cells where the prisoners lived and worked alone. Each cell had its own exercise yard. Prisoners were separated even in church by tall screens to prevent them from seeing other inmates. By the 1850's, however, the *separate* system had been largely superseded by the *silent* system, mainly because of overcrowding. In the silent system, the prisoners worked and exercised with other inmates, but they were forbidden to talk to, or even look at, each other.

Later reformers introduced the idea of an *indeterminate* sentence, dependent on the prisoner's behaviour. Good conduct and hard work led to privileges and association with other inmates. These ideas were tried in Ireland, France, and the English penal colony on Norfolk Island, off the coast of Australia. There, prisoners gained marks for good conduct and hard work, or lost them for bad behaviour. When they reached the required number of points, they could be released. Other reformers introduced the idea of conditional release, whereby a prisoner was released before the end of his sentence provided he complied with certain conditions. If not, he was returned to prison. This led to the parole system, widely used today.

**Reforms in the 1900's** have led to further improvement of prisons. In the 1930's, for example, prisons began to develop rehabilitation programmes based on the background, personality, and physical condition of the individual inmate. This approach made rehabilitation programmes more meaningful. But despite such efforts, attempts to rehabilitate offenders had disappointing results. Many failed because of poorly trained staff, lack of funds, and ill-defined goals.

By the 1960's, many people felt that criminals could be helped better outside prison. As a result, many countries began to set up *community correctional centres* and *halfway houses.* Offenders lived in these facilities just before release and received counselling to help them adjust to life outside prison. The number of prison inmates declined. But community correction programmes also failed to meet expectations, and prisons again became the most preferred institution.

### Prisons today

**Current problems.** Severe overcrowding is now the major problem in most prisons. Cells originally built for one prisoner, now often house two or three men. Judges in the United States have ruled that many prisons are so crowded that they violate prisoners' constitutional protection from "cruel and unusual punishment." In the United Kingdom, conditions became so bad that prisoners were held in disused army barracks and police cells. Overcrowding was eased temporarily by releasing non-serious offenders on parole.

Prisons face other problems as well. A lack of adequate funding has made improvements difficult. In addition, tensions among prisoners and between prisoners and the prison staff often run high and lead to brutal attacks. Such conditions, worsened by overcrowding, have contributed to a number of prison riots since the late 1960's. In a push to cut costs and improve efficiency, the British government began in 1993 to transfer the running of some prisons to private companies.

**Continuing debate.** The current concern with crime and the problems of prisons have helped focus public attention on the continuing debate about the purposes and effectiveness of prisons. Studies have shown that even good rehabilitation programmes fail to reform many released prisoners. The apparent failure of such programmes has led many people to stress imprisonment as punishment rather than as treatment. On the other hand, experts also have failed to prove that prisons reduce the crime rate either by incapacitating offenders or by discouraging people from breaking the law. For this reason, some experts believe that it would be cheaper, more humane, and more productive to keep all except dangerous offenders in community correctional centres rather than in prisons.

Some courts are experimenting with sentences that allow criminals to remain out of prison. Some of these sentences require criminals to repay the victims of their crimes, and others make offenders perform various public services in the community.

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| Fry, Elizabeth G. | Prison hulks | |


**Prison hulks** were ships used to accommodate British convicts. The ships were anchored on the River Thames and in the naval harbours of southern England. This system was adopted in 1776, after American opposition forced the British government to stop the transportation of convicts to the American colonies. Convicts on the hulks laboured during the day on public works projects, such as dredging sand and silt. By the standards of that time, the system worked fairly well. The conditions on the hulks seem to have been better than those in ordinary prisons of the time. But there were periodic outbreaks of disease on the hulks. Prison reformers also opposed the hulks because the crowded conditions lowered morale among prisoners.

The use of prison hulks finally ended when the number of prisoners being sentenced by the courts caused the hulks to become impossibly overcrowded. As a result, the government eventually accepted the recommendations of Sir Joseph Banks to transport convicts to Botany Bay in Australia. The First Fleet of convicts sailed in 1787 and landed in Australia in 1788.

**Prisoner of war,** or *POW,* is a captured member of a warring country's armed forces. In most cases, prisoners of war have surrendered to their enemy. But sometimes they have been taken by force.

In 1785, the United States and Prussia signed the world's first treaty calling for fair treatment for prisoners of war. The Hague Conventions of 1899 and 1907 and the Geneva Conventions of 1929 and 1949 established inter-

national rules dealing with the treatment of prisoners of war. Nearly all nations have agreed to follow these rules.

The Hague and Geneva conventions require that nations keep their prisoners of war in safe, sanitary camps. Representatives of nonfighting countries must be allowed to inspect the camps. These inspectors make certain that prisoners of war receive food, medical care, and payment for work. The conventions also rule that nations must permit their prisoners to send and receive mail. Another regulation requires that countries return captured military doctors and chaplains to their own forces. The conventions provide that a prisoner need not give the enemy any information except the prisoner's name, rank, military serial number, and age.

In spite of the Geneva and Hague regulations, much mistreatment of prisoners of war has occurred. During World War II (1939-1945), Germany, Japan, and the Soviet Union treated their prisoners harshly. Millions of them died of cold, starvation, or mistreatment. During the Korean War (1950-1953), United Nations (UN) forces accused the Chinese and the North Koreans of *brainwashing* their prisoners (see **Brainwashing**). But most nations have respected the prisoner of war regulations. As a result, millions of prisoners have survived capture. By the end of the Vietnam War (1957-1975), 651 American and thousands of North Vietnamese prisoners of war returned to their own countries.

See also **Geneva Conventions; Korean War** (The truce talks).

**Pritchard, Sir John** (1921-1989), a British opera and orchestral conductor, was chief conductor of the British Broadcasting Corporation (BBC) Symphony Orchestra from 1982 to 1989. Previously, he had been chief conductor of Cologne Opera from 1978 and chief guest conductor of the BBC Symphony Orchestra from 1979. Pritchard was born in London. He served as conductor of the Royal Liverpool Philharmonic Orchestra from 1957 to 1963. From 1962 to 1966, Pritchard was musical director of the London Philharmonic Orchestra. He was musical director of Glyndebourne Opera from 1969 to 1977. He was knighted in 1983.

**Privateer** is a privately owned armed vessel. Before the development of strong navies, many nations commissioned privately owned ships to assist them in time of war. Such commissions, first used in the 1400's, were known as *letters of marque and reprisal,* and ships and crews acting under them were called privateers. The privateers attacked merchant ships of the enemy nation.

Privateers helped the colonies against Great Britain in the American Revolution. On March 18, 1776, the Second Continental Congress authorized privateers. This action was taken after the British Parliament had prohibited all trade with their American colonies and authorized seizure of their ships. George Washington was part owner of at least one privateer. Colonial privateers captured about 600 British ships.

From 1798 to 1801 the United States authorized privateers to seize French vessels, because many American ships were being taken by warships of republican France. In the War of 1812, American privateers seized 1,345 British ships. Some became pirates after the war.

In 1856, the United States refused to sign the Treaty of Paris outlawing privateering because it feared it might need privateers to support its weak navy.

**Common privet** grows as a shrub or small tree. It has dark green, glossy leaves, and white, scented flowers.

During the American Civil War (1861-1865), the Confederate government issued letters of marque, but after the first year of war a volunteer naval system was substituted for privateering. The federal government tried privateering in 1863, and Chile used it against Spain in 1865. These were the last known instances of privateering.

**Privet** is a popular shrub for hedges. It is usually pruned and trained as a close-growing hedge, but is sometimes allowed to grow tall. It then forms a large bush about the size of its close relative, the lilac. The white flowers of privets are much smaller and less showy than those of the lilac, but are similar in general shape. Their odour is less sweet than that of the lilac. The privet is also related to the olive tree, and its smooth, dark-skinned fruit resembles a tiny ripe olive.

The common privet is native to southern Europe and to northern Africa. Other species grow wild in Asia and Australia. All parts of the privet plant are poisonous if eaten.

**Scientific classification.** Privets belong to the olive family, Oleaceae. The common privet is *Ligustrum vulgare.*

**Privy Council** is an honorary council appointed by the Crown of Great Britain. Members of the Privy Council include Cabinet members, other political leaders, judges, and scholars. Privy councillors are selected from all countries of the Commonwealth of Nations that recognize the British monarch as their symbolic head of state. The title of councillor is honorary in most cases. Council members become salaried officials only when they are given a place in the Cabinet. The lord president of the council is a member of the British Cabinet.

Council members serve during the life of the sovereign who appointed them, and for six months after the sovereign's death. The full council meets on rare occasions, such as the beginning of a reign, or when the reigning sovereign announces his or her marriage. The administrative work of the council is carried on through state departments. Each department is headed by a minister responsible to Parliament. The Judicial Committee is the highest judicial authority in the British Commonwealth. Members of the Privy Council use the title *Right*

*Honourable* before their names, and letters *P.C.* (privy councillor) after their names.

The beginning of the Privy Council can be traced to the council of William the Conqueror. The council advised William the Conqueror on matters of state, and set the laws for the kingdom. The importance of the council declined as Parliament increased in power.

The British North America Act of 1867 established the King's (or Queen's) Privy Council for Canada. The Cabinet of the Dominion of Canada sits as a committee of the Canadian Privy Council. Until 1986, appeals from courts in Australia were made to the Judicial Committee of the Privy Council, which sat in London. Since 1986, the highest court of appeal in Australia has been its High Court.

**Privy Seal** is an official stamp that was once used on public documents in Britain. The Privy Seal authorized the issue of money from the Treasury and was the stamp of approval for documents passing to the keeper of the Great Seal. Use of the Privy Seal was discontinued in 1884, but the office of keeper of the Privy Seal still exists. Today, the keeper's official title is Lord Privy Seal.

**Probability.** When we say that one event is more probable than another, we mean it is more likely to happen. The branch of mathematics called *probability theory* tries to express in numbers statements of the form: An event *A* is more (or less) probable than an event *B*.

If a person tosses a coin, there are only two ways it can fall—heads or tails. It is as likely to fall one way as the other. Thus we say that the probability of throwing heads is $\frac{1}{2}$. If the coin is tossed 100 times and $x$ is the number of times heads occurs, we can expect the ratio $\frac{x}{100}$ to be close to $\frac{1}{2}$. More generally, if a coin is tossed $n$ times and $x$ is the number of times heads occurs, the ratio $\frac{x}{n}$ will be very close to $\frac{1}{2}$ if $n$ is very large.

Now suppose a person tosses three coins. There are eight possible outcomes: *hhh, hht, hth, thh, htt, tht, tth,* and *ttt*. *Three* of these outcomes have two heads, so the probability of throwing two heads is $\frac{3}{8}$. Only *one* outcome has exactly three heads, so the probability of throwing three heads is $\frac{1}{8}$. The event *two heads* is more probable than the event *three heads*. If a set of three coins is tossed a very large number of times, we would expect two heads to occur very nearly $\frac{3}{8}$ of the time and three heads to occur very nearly $\frac{1}{8}$ of the time.

Probability is the foundation of the science of statistics. A political scientist, for example, may gather data and use statistics to predict the percentage of voters who will vote for a particular candidate in an election. The political scientist then uses probability to calculate the possible error of the estimate.

See also **Fermat, Pierre de; Pascal, Blaise; Permutations and combinations; Statistics.**

**Probate.** When people die, their wills must be *admitted to probate* (proved to be genuine). A deceased person's executors bring the will before a court where wills and estates are handled. This court is usually called the *probate court*. The executors present the will and show proof that it is the true will of the deceased. A will should be admitted to probate soon after the death of the person who made it, called the *testator*. After the will is presented, the court usually issues a notice to the testator's heirs who would have shared the property if no will had been made.

A hearing is then held in the probate court, and the heirs are given a chance to object to the will. Witnesses are examined just as they are in a civil case. The judge then decides whether or not the will is genuine. A will may be denied probate if the testator lacked mental capacity or was subjected to undue influence. If all requirements have been met, the will is approved, and the executors carry out its provisions.

See also **Executor; Will.**

**Probation** is a judicial act that allows a convicted criminal to remain free in society instead of serving a sentence in prison. Probation is most frequently granted by a judge to people who have been convicted of an offence other than the most serious crimes, such as armed robbery, murder, or rape. Probation gives such persons a chance to prove that they will not repeat their crime. The word *probation* comes from the Latin word for *prove* or *test*.

Many criminologists believe that probation encourages good conduct by the *probationer* (person on probation). Probation enables the offender to avoid the harmful effects of being imprisoned with experienced criminals. It also costs the taxpayers less than imprisonment because a probationer does not have to be fed, clothed, housed, and guarded in a jail.

When a judge decides to grant probation, the offender is asked whether he or she agrees to the order. If so, the judge places the offender under the supervision of a court official called a *probation officer*. The judge also sets the period of probation, which can range from six months to five or more years, depending on the rules in a particular country. During this time, the probationer must follow certain rules of conduct called *conditions of probation*. The probationer also must meet regularly with a probation officer to discuss any problems or other matters connected with the case that have arisen.

At the end of the probation period—if the probationer has avoided getting into trouble—the trial judge releases the probationer from all supervision. But if the conditions of probation have been violated at any time during the probation period, the probation officer may report the violations to the judge. The judge may send the probationer to prison for the original crime if the probationer has violated any of the conditions of probation.

Probation differs from *parole* and *pardon*. Parole is the release of a convict who has served part of a sentence. A pardon usually excuses a person from any punishment for a crime.

**Problem solving.** See **Research** (How a researcher works); **Science** (How scientists work).

**Proboscis.** See **Butterfly** (The head; pictures); **Fly** (The body of a fly); **Moth** (The head; pictures).

**Proboscis monkey** is a large, leaf-eating monkey that lives on the island of Borneo in Southeast Asia. This monkey gets its name from its *proboscis* (long nose). A male proboscis monkey weighs up to 24 kilograms, and a female weighs up to 12 kilograms. These monkeys measure from about 50 to 75 centimetres long, not including the tail.

Adult proboscis monkeys have reddish hair on their heads, backs, shoulders, and thighs, and pale grey hair on their arms and legs. Infant monkeys are born with silver-blue fur that turns grey after about three months.

Proboscis monkeys have sharp back teeth that enable them to shred leaves easily. They have a well-developed thumb adapted to picking leaves and other plant parts. These monkeys live in trees near rivers. They feed mainly on leaves and also eat fruit and flowers.

Proboscis monkeys are good swimmers. Crocodiles prey on the monkeys in rivers and streams. But continual clearing of trees in the monkeys' environment for agricultural purposes is the main threat to the animal's existence.

**Scientific classification.** The proboscis monkey belongs to the Old World monkey family, Cercopithecidae. It is *Nasalis larvatus.*

See also **Monkey** (picture).

**Procaine** is a drug used to block pain sensation in a specific part of the body. Such drugs are called *local anaesthetics.* Doctors use injections of procaine to produce *regional nerve blocks* and *spinal anaesthesia* (see **Anaesthesia** [Local anaesthesia]).

Procaine is a white, crystalline powder. It is chemically similar to the local anaesthetics benzocaine and cocaine. Unlike those anaesthetics, however, procaine does not produce anaesthesia when applied to the surface of the skin or mucous membranes.

A German chemist, Alferd Einhorn, first synthesized procaine in 1905. It soon replaced cocaine as the drug of choice for regional nerve block anaesthesia, and for many years it served as the standard to which other local anaesthetics were compared. The use of procaine has declined since the introduction of the local anaesthetic lignocaine in the 1940's.

See also **Cocaine; Lignocaine.**

**Proclamation** is an executive notice issued under the authority of the head of a country. It announces some order or regulation that is important to the people of the country. A proclamation that grants a pardon to rebels is a *proclamation of amnesty.* A proclamation may declare a public holiday. Usually a proclamation appears in printed form. See also **Emancipation Proclamation.**

**Proclamation Day** is the day on which the South Australians celebrate the proclamation of the colony of South Australia. The first Proclamation Day was held on Dec. 28, 1836. It was celebrated under a gum tree, now known as the *Old Gum Tree.* The remains of the tree are preserved in a small park surrounded by houses in the suburb of Glenelg. John Hindmarsh, the first governor of the colony, read the royal order that made South Australia a province of Great Britain. Oaths of office were taken in the presence of 200 colonists. Most of the first proclamation was concerned with the proper treatment of the Aborigines. An annual ceremony, held at the Old Gum Tree, honours it.

**Procurator fiscal** is an officer of the judicial system in Scotland. The *procurator fiscal service* undertakes public prosecutions on behalf of the Lord Advocate and the Solicitor General, Scotland's two chief legal officers. A crown agent supervises the service, which is staffed at the local level by lawyers known as *procurators fiscal.* The police investigate offences and report them to the local procurator fiscal, who decides whether or not to prosecute the case in the sheriff or district court.

Coroners do not exist in Scotland. The procurators fiscal inquire into sudden or suspicious deaths in their district. They may report their findings to the crown agent.

**Producer.** See **Film industry** (How films are made); **Theatre** (Broadway).

**Production** is a major step in the series of economic processes that bring goods and services to people. Other main steps include *distribution* (getting the goods to people who use them) and *consumption* (the final use of the goods). For example, the producers of a loaf of bread include the people who grow the grain, those who make flour, and those who bake the loaves. The bakery salespeople and the truck drivers who deliver the bread are distributors. Consumers buy and eat the bread. In a balanced economy, production and consumption are about equal and goods flow smoothly from maker to user.

A balanced economy is one in which the vast majority of people who want to work have jobs, and the total amount of production is sufficient to satisfy the needs and wants of the people. When a lack of balance exists, some blame can be placed on consumption, because many people do not have money to buy goods they want. Other factors, such as technological change, overextension of credit, and improper distribution of goods can unbalance the economy.

See also **Consumption; Economics; Factory; Marketing; Mass production; National income.**

**Profit** is the amount of money a company has left over from the sale of its products after it has paid for all the expenses of production. These expenses include costs of such things as raw materials, workers' salaries, and machinery. They also include a reasonable return on the owner's investment, a salary for the labour the owner supplies to the firm, and other costs that are hard to calculate. A main task of accounting is to define and measure profits accurately.

Profits are vital to the economic system of countries where private enterprise is encouraged. In such countries, profits belong to the owners or shareholders of companies. One of the chief reasons for operating a business is to make a profit, and this motivates companies to produce their goods efficiently. The lower a company's costs are, the greater its profits can be.

A business can earn a profit only by producing goods and services whose selling price is greater than the cost of producing them. Therefore, business executives seek to use labour and raw materials to produce and sell things for which customers will pay a price that is greater than the cost of production. Thus, the search for profits is also the search for the uses of a country's labour and raw materials that will satisfy consumers most completely.

Some business executives constantly lower prices to capture sales and profits from their competitors. However, there are several reasons why competition does not eliminate profits. For one thing, at any one time, there will be many firms that have discovered profitable opportunities their competitors cannot yet match. Sometimes, new firms cannot duplicate a profitable product because of patents or trademarks, or for other reasons. Sometimes, new firms cannot produce goods as cheaply as established ones. The bother and risk of entering an unfamiliar industry also keeps some new firms from competing with a product that is not especially profitable. The established firms can then enjoy reasonable profits without fear of new competition.

See also **Capitalism (Businesses)**; **Price**; **Accounting**; **Business**.

**Profit sharing.** Many employers share part of their profits with their employees. They do this to encourage *productivity* (productive work) and to induce the employees to remain with the company.

Profit-sharing plans are usually based on the net profit of the firm, after all interest, taxes, and other charges against the gross profits have been paid. A certain percentage of the profit is set aside for the employees, and workers share in it according to their salary or their length of service with the company.

Some industrialists object to profit-sharing plans, because workers do not share the responsibilities and risks of the business. Some union leaders also oppose such plans, believing that workers should concentrate their efforts on obtaining higher wages. But other industrialists and union leaders believe that properly administered profit-sharing plans promote better understanding between employer and employees, and stimulate efficiency, since both employer and employees share in any gains achieved by joint effort.

**Progeria** is an extremely rare disorder that causes premature aging in children. The disease is also called *Hutchinson-Gilford syndrome*. It was first described in 1886 by Sir Jonathan Hutchinson, an English doctor. Since then, only about 100 cases of progeria have been reported worldwide. The disease occurs only once in every 4 million births. The word *progeria* comes from a Greek word that means *prematurely old*.

Most people with progeria appear normal at birth, but they soon begin to grow more slowly than normal. By 1 or 2 years of age, their hair turns lighter in colour and starts to fall out. By age 3 or 4, they are almost bald. In addition, their skin becomes thin, wrinkled, and spotted, their bodies take on a stooped appearance, and their facial features look "pinched." Their heads appear unusually large and veiny.

Many people with progeria develop disorders of the circulatory system, especially high blood pressure, heart disease, and stroke. Some victims die as early as 7 years of age. About half die by age 13. The oldest known person with progeria lived 27 years.

The disease does not affect a person's mental development. Many people with progeria are highly intelligent. Most victims are very shy because of their physical appearance. Although people who have progeria continue to grow slowly, few reach a height of 110 centimetres or a weight of 18 kilograms.

Scientists do not know the cause of progeria and there is no effective treatment. The rareness of the disease makes it difficult to study.

**Progesterone** is a hormone produced mainly by the ovaries and the placenta in female animals during the years when they are able to bear young. Small amounts are also produced by the adrenal glands in both females and males and by the testes in males.

Progesterone plays an important role in preparing a woman's uterus for pregnancy. About midway through a woman's monthly menstrual cycle, one of her two ovaries releases an egg. This process, called *ovulation*, causes changes in the ovary so that it releases high levels of progesterone into the blood for 10 to 12 days. Progesterone stimulates the lining of the uterus so that the egg, if it has been fertilized, may attach to the uterine wall. If pregnancy does not occur, the ovary stops producing high levels of progesterone. The uterine lining then breaks down and passes out of the body during menstruation. See **Menstruation**.

The monthly increase of progesterone in a woman's blood after ovulation causes cyclic changes in other body functions. For example, the woman's body temperature increases, and her breasts may enlarge or become especially sensitive. During pregnancy, the placenta produces large amounts of progesterone. The high progesterone level keeps the uterine muscle relaxed so the baby is not born too soon. See **Placenta**.

Doctors use progesterone as a drug to treat disorders of the reproductive system, such as premenstrual tension and irregular menstruation. Synthetic forms of progesterone are used alone and in combination with synthetic oestrogens in birth control pills.

See also **Steroid**.

**Programmed instruction.** See **Teaching machine**.

**Progression,** in mathematics, is a sequence of related numbers or symbols called *terms*. The following examples illustrate three common kinds of progressions:

*Arithmetic progression:* 1,2,3,4,5,6, . . . and so on;
*Geometric progression:* 2,4,8,16,32, . . . and so on;
*Harmonic progression:* $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{6}$, $\frac{1}{8}$, . . . and so on.

In each of these progressions, the terms after the first are formed in different ways. Each term of an arithmetic progression is formed by *adding* a quantity called the *common difference* to the previous term. In the example, the common difference is 1. Each term of a geometric progression is formed by *multiplying* the previous term by a quantity called the *common ratio*. In the example, the common ratio is 2. Each term of a harmonic progression is a fraction. The numerators are all 1's and the denominators are formed like the terms of an arithmetic progression. In the example, the common difference of the denominators is 2.

Progressions are useful in solving many problems in science and business. For example, they simplify the calculation of compound interest (see **Interest**). Mathematicians have developed formulas for finding the value of any term of a progression and for finding the sum of any number of terms.

**Arithmetic progressions** may have various first terms and common differences. Some examples are shown below:

| | First term | Common difference | Arithmetic progression |
|---|---|---|---|
| A | 2 | 3 | 2, 5, 8, 11, 14, 17, . . . |
| B | 3 | −2 | 3, 1, −1, −3, −5, . . . |
| C | 1 | $\frac{1}{2}$ | 1, $1\frac{1}{2}$, 2, $2\frac{1}{2}$, 3, . . . |
| D | $a$ | $d$ | $a, a+d, a+2d, a+3d, \ldots$ |

In example A, the 4th term (11) is equal to $2 + 3 + 3 + 3$, which can also be written $2 + (4 - 1)3$. The value of *any* term can be found by adding to the first term the product of the common difference times one less than the number of the term. In general, $a$ can be used to represent the first term, and $d$ the common difference. The formula for the $n$th term ($U_n$) is

$$U_n = a + (n-1)d$$

The sum of the first 6 terms of example A is 2 + 5 +

$8+11+14+17=57$. Note that the sum of the first and last terms (2,17) is 19. Likewise, the sums of the 2nd and 5th terms (5,14) and the 3rd and 4th terms (8,11) are also19. The sum of all 6 terms (57) is equal to 3 times 19, or 3 times the sum of the first and last terms. In general, the sum of any number of terms of an arithmetic progression is one-half the number of terms times the sum of the first and last terms. If we use the symbol $S_n$ to represent the sum, the formula is

$$S_n = \frac{n}{2}(a+U_n)$$

**Geometric progressions** may have various first terms and common ratios as shown below:

| | First term | Common ratio | Geometric progression |
|---|---|---|---|
| A | 2 | 3 | 2, 6, 18, 54, 162, . . . |
| B | 1 | $\frac{1}{2}$ | $1, \frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \frac{1}{16}, \ldots$ |
| C | $a$ | $r$ | $a, ar, ar^2, ar^3, \ldots ar^{n-1}, \ldots$ |

Example C indicates that the value of the $n$th term ($U_n$) is $ar^{n-1}$. The exponent $(n-1)$ means that $r$ is to be used as a factor $(n-1)$ times. Using this formula, the 6th term in example A can be calculated:

$$U_6 = 2(3)^5 = 2\times3\times3\times3\times3\times3 = 486$$

The sum of $n$ terms can be calculated by the formula

$$S_n = \frac{a-ar^n}{1-r}$$

For example, the sum of the first 4 terms of example A is calculated as follows:

$$S_4 = \frac{2-2(3)^4}{1-3} = \frac{2-162}{-2} = 80$$

If $r$ is less than 1, the sum of an *infinite* number of terms approaches the limit $a/(1-r)$. See **Series** (Working with infinite series).

**Progressive Democrats (PD's)** are the third largest political party in the Republic of Ireland. The party was formed in December 1985 by two members of Dáil Éireann (the Irish Parliament), Desmond O'Malley and Mary Harney. O'Malley became the party's president and leader. In the general election of February 1987, the PD's won 14 seats in Dáil Éireann and replaced the Labour Party as the country's third largest party. In the general election of June 1990, the PD's won only 6 seats. But they joined Fianna Fáil in a coalition government.

The aims of the PD's include a commitment to enterprise and to wider participation in the economy, with a reduction of the state's role in the economy. The party also aims to provide political leadership independent of church influence and without reference to individual or party gain.

See also **Oireachtas; O'Malley, Desmond; Political party.**

**Progressive movement** was a campaign for economic, political, and social reform in the United States. It began during a nationwide depression that lasted from 1893 until about 1897. The movement ended when the United States entered World War I in 1917. Americans turned their attention from reform to war.

Industry in the United States had grown swiftly during the 1800's. This rapid industrialization caused such problems as business monopolies, dishonest politics, crowded city slums, and poor working conditions in factories and mines. During the 1890's and early 1900's, many reformers helped bring about laws aimed at relieving these problems. The reformers began to call themselves *progressives* about 1905. They had their greatest effect at the local and state levels, where the movement began. Opposition to reform was much stronger at the national level, though the U.S. Congress did adopt some of the progressives' key measures.

**Economic reforms** of the progressive movement included increased government regulation of business and a series of tax reforms. In 1890, Congress passed the Sherman Antitrust Act, which banned industrial monopolies that limited competition. But the act had little immediate effect, partly because its wording was vague. Progressives worked for a stronger law to prevent business abuses. In 1914, Congress set up the Federal Trade Commission to stop illegal business practices.

Before the progressive movement, many taxes had been based on property. But many wealthy people hid such property as stocks and bonds from the government and did not pay taxes on them. Largely for this reason, progressives demanded that taxes be based on income rather than on property. In 1911, the U.S. state of Wisconsin passed the first effective state income tax law. Two years later, Congress enacted what became the first permanent federal income tax in the United States.

**Political reforms.** Many city and state governments were controlled by dishonest business executives and politicians who tried to block economic reforms. But in the 1890's and early 1900's, progressive mayors gained office in a number of cities. These mayors, including Tom L. Johnson of Cleveland and Samuel M. Jones of Toledo, Ohio, worked to end corruption in law enforcement, public transportation, and other city services. Progressives also worked to increase the political power of the voters. In 1903, Los Angeles became the first city to approve *recall,* which let voters remove a person from public office before his or her term ended.

State governments also adopted political reforms. A number of states granted *home rule,* the right of a city to govern itself. In 1898, South Dakota passed the first state *initiative* and *referendum* laws. Under the initiative, voters could pass laws without the need for the state legislature's approval. The referendum enabled voters to overrule laws adopted by the legislature. Wisconsin, led by Governor Robert M. La Follette, adopted the first effective state *direct primary law* in 1904. This law allowed the voters to nominate candidates. Previously, each political party had held a convention at which delegates nominated candidates.

Political reforms on the federal level included the 17th Amendment to the U.S. Constitution. This amendment, adopted in 1913, provided for the direct election by the people of U.S. senators. The state legislatures had previously elected U.S. senators.

**Social reforms** of the progressive movement included improvements in the living and working conditions of the poor. Many states passed housing regulations to help relieve crowded city slums. In some slums, progressives set up centres called *settlement houses.* Reformers and slum residents met in them and worked to improve slum conditions. One famous settlement house was Hull House in Chicago, founded in 1889 by

Jane Addams and Ellen Starr, two social workers.

In many factories and mines, employees worked long hours for low wages and operated unsafe machinery. Progressives helped bring about state laws that required safety precautions in factories and allowed workers to collect money for injuries suffered at work. Some states also set a minimum wage.

In the early 1900's, writers called *muckrakers* exposed many social and political injustices in the United States. Their works helped bring about many reforms. Leading muckrakers included Jacob Riis, Upton Sinclair, and Lincoln Steffens. Each of these writers has a separate biography in *World Book.*

In spite of their achievements, progressives failed to significantly curb the power of large businesses. However, they exposed injustices and created the patterns of reform that became the basis for reform movements later in the 1900's.

See also **Addams, Jane; Roosevelt, Theodore; Taft, William Howard** (Legislative achievements); **United States, History of the** (Reform).

**Prohibition** is the prevention by law of the drinking of alcoholic beverages. Prohibition laws forbid the manufacture, sale, or transportation of such beverages. Alcoholic beverages include beer, gin, rum, vodka, whisky, and wine. In Islamic countries, such as Saudi Arabia, prohibition is an important part of the law. But the term *prohibition* is generally taken to refer to a period in the history of the United States.

In the United States, a prohibition amendment was added to the U.S. Constitution in 1920. This amendment, the 18th Amendment, caused the use of alcoholic beverages to decline sharply. However, many people ignored the national ban and drank illegal beverages supplied by networks of *bootleggers* (illegal makers and smugglers of liquor). The 18th Amendment was abolished in 1933. It is the only amendment to the U.S. Constitution that has ever been repealed.

### Prohibition in the United States

**The movement toward prohibition.** In the 1600's and 1700's, the American colonists drank large quantities of beer, cider, rum, and wine. Such alcoholic beverages were often safer to drink than impure water or unpasteurized milk and were less expensive than coffee or tea. By the 1820's, people in the United States were drinking, on average, the equivalent of 26 litres of pure alcohol per person each year. This amount of alcohol is in about 260 litres of beer, 150 litres of wine, or 60 litres of distilled liquor.

Some people, including doctors and ministers, became concerned about the extent of alcohol use. They believed that drinking alcohol damaged people's health and moral behaviour, and promoted poverty. People concerned about alcohol use urged *temperance*—that is, the reduction or elimination of the use of alcoholic beverages.

At first, supporters of temperance urged drinkers to drink only moderate amounts. But the supporters later became convinced that all alcoholic beverages were addictive. As a result, they tried to end the use of alcohol. In the 1820's and 1830's, the first temperance crusade reduced the average annual intake of pure alcohol per person to about 11 litres. During the 1850's, about a dozen states passed prohibition laws, led by Maine in 1851.

**U.S. government agents** seized huge quantities of illegal beer and liquor during the Prohibition Era. Underworld gangs made millions of dollars from the sale of such alcoholic beverages. Agents dumped much beer into Lake Michigan, *above.*

Support for prohibition declined after the Civil War began in 1861. To revive support, people who favoured prohibition, often called *drys* or *prohibitionists,* formed a number of organizations to promote liquor reform. In 1869, for example, drys founded the Prohibition Party, which presented prohibitionist candidates for political office. In 1874, a group of Protestant women established the Woman's Christian Temperance Union (WCTU). Drys organized the Anti-Saloon League in 1895.

From about 1900 to 1920, numerous economic, political, and social reforms were carried out in the United States. During this period, many reformers supported national prohibition, and they did so for a variety of reasons. Social reformers blamed alcohol for poverty, health problems, and the neglect by husbands of their wives and children. Political reformers saw saloons as the backbone of corrupt urban political organizations. Employers felt that drunkenness reduced their workers' safety and productivity.

During the early 1900's, some people felt that the large numbers of recent immigrants to the United States would become more "American" if their drinking habits were changed. Many religious denominations taught that drinking alcohol was immoral.

Between 1880 and 1914, many states adopted either statewide prohibition or *local-option laws.* Local-option laws gave individual communities the right to ban the sale of alcohol. In 1913, Congress passed the Webb-Kenyon Act, which forbade the mailing or shipping of liquor into any state that banned such shipments. That same year, drys began calling for a prohibition amendment to the U.S. Constitution.

When the United States entered World War I in 1917, most Americans considered prohibition an appropriate patriotic sacrifice. In December 1917, the U.S. Congress approved the 18th Amendment to the Constitution. This amendment prohibited the manufacture, sale, transportation, import, and export of "intoxicating liquors." It was ratified by the states in January 1919. In October 1919, Congress adopted the Volstead Act. This law provided

for the enforcement of the 18th Amendment and defined *intoxicating liquors* as those containing at least 0.5 per cent alcohol. The 18th Amendment went into effect in 1920 with widespread support.

**Life during prohibition.** Although national prohibition did not eliminate the drinking of alcoholic beverages, it did sharply reduce their use. Purchasing liquor was not only against the law, but it was also very expensive. However, a large minority of Americans continued to drink alcohol. Drinking wine, beer, and other alcoholic beverages had been a traditional part of the cultures of many recent immigrants to the United States, including Irish, Italians, Jews, and Poles. In addition, numerous urban middle- and upper-class Americans considered drinking sophisticated and sociable.

During prohibition, many people made their own beer, wine, or distilled liquor at home illegally. Also, numerous people bought alcoholic drinks in illegal bars called *speakeasies.* Many doctors gave their patients prescriptions for legal "medicinal" wine or liquor.

Bootleggers met much of the demand for illegal alcoholic beverages. Most bootleggers were young immigrant men. The liquor trade was highly profitable, and bootleggers battled each other for control of liquor supplies and markets. Violent gang wars erupted in many large cities, and gang members killed one another at a furious pace. Al Capone of Chicago was probably the era's most famous bootlegger.

During the late 1920's, more than 3.8 million litres of liquor was smuggled into the United States each year from Canada. Liquor also was smuggled into the country from ships located just beyond U.S. waters in the Atlantic or Pacific oceans or in the Caribbean Sea. In addition, alcoholic beverages were made from alcohol that was legally produced in the United States for use in manufacturing. Neither federal agents nor state and local officials could stop the widespread violation of national prohibition.

**The decline of the prohibition movement.** Antiprohibitionists opposed prohibition for a number of reasons. They argued that the ban on alcohol encouraged crime and disrespect for the law. They also claimed that prohibition gave the government too much power over people's personal lives. Recent immigrants to the United States saw prohibition as an attack on their cultural traditions. After the Great Depression began in 1929, many people argued that prohibition took away jobs and deprived the government of badly needed revenues from taxes on liquor.

In the 1932 presidential campaign, the Democratic Party endorsed the repeal of prohibition, and the Democratic presidential candidate, Franklin Delano Roosevelt, won the election by a large margin. In February 1933, Congress proposed the 21st Amendment to the Constitution to repeal the 18th Amendment. The states quickly ratified the 21st Amendment, and national prohibition ended on Dec. 5, 1933.

A few states, mainly ones in the South, retained prohibition until the 1950's or 1960's. In 1966, Mississippi became the last state to repeal statewide prohibition. Since then, most efforts to forbid the use of alcohol by adults have been abandoned. Attention has shifted instead to the treatment of alcoholism and to the solution of other alcohol-related problems.

### Prohibition in other countries

The drinking of alcohol is prohibited by law, on religious grounds, in Muslim countries. It is also prohibited under Hindu law in India, but India has no formal national ban on drinking alcohol. However, some Indian states have laws prohibiting the consumption and sale of alcohol. In India in the 1930's and 1940's, Mohandas Gandhi campaigned for prohibition. He felt that alcohol consumption kept India's poor people in poverty. In the late 1970's, Indian prime minister Moraji Desai excluded known drinkers from his cabinet, but failed to get prohibition introduced nationally.

Prohibition has been introduced in various societies throughout history. Peoples as diverse as the Aztec and the ancient Chinese have imposed bans on the making, selling, and drinking of alcohol, often for religious or moral reasons. In the 1900's, Canada, Iceland, Russia, and the Scandinavian countries all introduced prohibition for a time but repealed it later.

**Related articles** in *World Book* include:

Chicago (The Roaring Twenties)
Nation, Carry
Roaring Twenties (Changing attitudes)
Volstead Act
Woman's Christian Temperance Union

**Projectile.** See **Ammunition; Guided missile** (Ballistic missiles); **Rocket; Torpedo.**

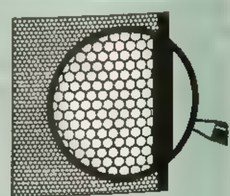
**Projection screen** is a square or rectangular device on which films or slides are shown. A screen reflects an enlarged image of the projected film or slide so that many people can view it at one time.

Most projection screens are made of fabric. They differ greatly in size. This article discusses the small portable screens that are used in such places as homes, schools, and libraries. For information on the large, permanently mounted screens used in cinemas, see **Film industry** (How films work [The screen]).

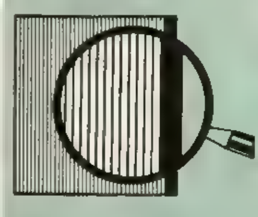
Most portable screens measure from about 75 by 100 centimetres to 150 by 150 centimetres. Screens are clas-

**Kinds of portable projection screens**

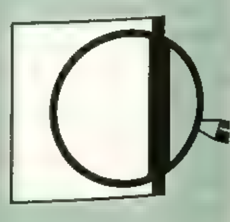
Portable projection screens are often classified by their surface. *Glass-beaded* screens are covered with tiny beads. *Lenticular* screens have thin, lens-shaped ridges. *Matt* screens have a dull, non-glossy surface that lacks the brightness of the other types.



Glass-beaded screen



Lenticular screen

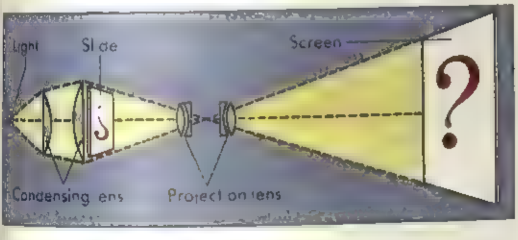


Matt screen

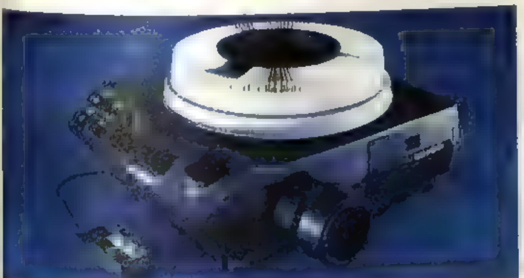
sified by their surface. *Glass-beaded* screens have tiny beads on the surface that provide a bright image when viewed from the centre of a room. *Lenticular* screens have thin, lens-shaped ridges on the surface and provide a sharp, bright image regardless of viewing angle. *Matte* screens are dull white and provide sharpness and a wide viewing angle. However, they provide less brightness than glass-beaded or lenticular screens.

**Projector** is a device used to show pictures on a screen. One common type is a device for showing photographic slides. The simplest projector consists of (1) a light, (2) a reflector that focuses the light, (3) a focusing lens, and (4) a projector lens.

A powerful light is needed to show pictures on a screen. A projector uses an *incandescent* bulb that glows with heat. Some projectors use bulbs as strong as




**A diagram of slide projection,** *above,* shows how a projector beams the image of a slide onto a screen. Rays from a powerful light are condensed and sent through the transparent slide. Lenses focus the rays to provide a clear image. The slide must be put into the projector upside down because the lenses invert the image on the screen. A slide projector, *below,* can hold more than 100 transparent slides or glass-mounted transparencies in its circular slide tray.



1,000 watts. The reflector, located behind the bulb, is a *concave* (inward curving) mirror. It focuses the bright light rays through a thick *plano-convex* lens that is flat on one side and round on the other. The flat side of this lens faces the bulb. The light rays entering the focusing lens are bent inward and brought together. The rays then pass through a transparent photographic slide that is placed upside down between the focusing and projection lenses. The projection lens turns the picture right side up and enlarges it.

Some kinds of projectors can be used with both slides and filmstrips. *Overhead projectors* show pictures above and behind the operator. The operator can face the audience and use the projector at the same time. Some projectors can project drawings, maps, pages of books, and other material that is opaque—that is, it is neither transparent nor on transparent film. These projectors are called *opaque projectors.* Many teachers use projectors with photographs and tape recorders to give a tape-slide presentation. Students can see pictures and listen to accompanying lectures, music, and sound effects.

See also **Filmstrip; Film industry** (The projector); **Projection screen.**

**Prokhorov, Alexander Mikhailovich** (1916- ), is a Russian physicist. In 1953, he and Russian physicist Nikolai Basov stated principles for using the energy of molecules to amplify microwaves. They developed these amplifiers, called *masers,* during the next two years (see **Maser**). For their work, Prokhorov and Basov shared the 1964 Nobel Prize in physics with the American physicist Charles H. Townes.

Prokhorov was born in Atherton, Australia. In 1946, he became a research physicist at the Lebedev Institute of Physics in Moscow. In 1973, he became head of the Institute of General Physics of the Academy of Sciences in Moscow.

**Prokofiev, Sergei Sergeyevich** (1891-1953), was a major Russian composer. His first symphony, the *Classical* (1918), symphonic fairy tale *Peter and the Wolf* (1936), and cantata *Alexander Nevsky* (1939) are among the most popular classical works of the 1900's. Prokofiev's music contains sharp humour, lyric melodies, and percussive use of instruments. Prokofiev was also a brilliant pianist and often performed his own concertos and solo piano works. His solo piano pieces and nine sonatas became an important part of keyboard music in the first half of the 1900's. Most notable are the *Visions fugitives* (1918) and Piano Sonata No. 7 (1943).

Prokofiev was born in Ukraine. From 1904 to 1914, he studied piano, composition, and conducting at the St. Petersburg Conservatory in Russia. Prokofiev moved to New York City in 1918 and settled in Paris in 1923. Two of his best-known compositions, Piano Concerto No. 3 and the opera *The Love for Three Oranges,* were first performed in Chicago in 1921.

In 1936, Prokofiev settled in Moscow. The major works he composed there include the ballets *Romeo and Juliet* (1938), *Cinderella* (1945), and *The Stone Flower* (1954). Prokofiev composed the first version of his important opera *War and Peace* in 1941 and 1942 and revised it from 1946 to 1952. His Symphony No. 5 (1945) is among the most successful of his seven symphonies.

**Proletariat.** See **Communism** (Origins).

**Prologue** is an introduction to a play or other writing. The term comes from two Greek words meaning *before* and *discussion.* The prologue explains the situation at the time the first scene of the play opens, or it may explain in general terms what the play is about. The prologue to Shakespeare's *Romeo and Juliet* tells the audience that the play concerns "a pair of star-cross'd lovers." Chaucer's prologue to his *Canterbury Tales* describes pilgrims going to Canterbury, England.

**Prometheus,** in Greek myths, was a member of the earliest race of gods, called Titans. Prometheus' father was Iapetus, and his mother was either Themis or Clymene.

The god Zeus plotted to destroy humanity by depriving the earth of fire. Prometheus stole fire from the gods and gave it to people. Zeus punished him by ordering him bound to a remote peak in the Caucasus Mountains.

Oil painting on canvas (1868) by Gustave Moreau; Musée Gustave Moreau, Paris

**Prometheus** was a Greek god who stole fire from the gods and gave it to people. As punishment, he was chained to a rock. Each day, an eagle tore out his liver, which grew back each night.

An eagle came to devour Prometheus' liver every day, and the liver grew back each night. After Prometheus had suffered for many centuries, the hero Hercules killed the eagle and set Prometheus free.

The Greek poet Hesiod described Prometheus as a trickster and a troublemaker. The Greek dramatist Aeschylus presented him as a tragic hero and a champion of humanity in his tragedy *Prometheus Bound.* The German composer Ludwig van Beethoven, the German author Johann Wolfgang von Goethe, and the English poet Percy Bysshe Shelley created works inspired by the Prometheus myth.

**Promethium** is a chemical element with symbol Pm. It is one of the rare-earth metals. Its atomic number is 61, its most stable isotope has a mass number of 145, and its most abundant isotope has a mass number of 147. Its melting point is 1042° C, and its boiling point is estimated to be about 3000° C. Three American chemists, J. A. Marinsky, Lawrence E. Glendenin, and Charles D. Coryell, first isolated promethium in 1945. The element exists as radioactive isotopes among the fission products of uranium, thorium, and plutonium. It does not occur naturally. See also **Element, Chemical** (table); **Rare earth.**

**Prominence.** See **Sun** (The sun's activity).

**Promissory note** is an unconditional and irrevocable promise made in writing to pay a specified sum of money, on demand or at a given date, to a designated person. It is usually a promise to repay money that has been lent for business purposes. The sum that is to be repaid is usually more than the sum lent. The difference is the interest on the loan. The person who signs the note is called the *maker.* The person to whom it is made payable is called the *payee.* The date on which payment is due is the *redemption date.*

A note containing the words "order of" before the name of the payee is *negotiable* and may be assigned, or passed, to a third party, who is known as the *holder.* To complete the assignment, the payee must *endorse* the note by signing his or her name on the back of the note and then, ideally, informing the maker in writing. If the payee simply signs on the back of the note, the note becomes *open.* An open note is negotiable by anybody and might be cashed or transferred illegally by any person finding it if it were lost. To minimize this danger, it is usual for the payee to assign the document to a specific individual.

The holder may, in turn, transfer the note to another person by endorsing it. This can go on until the redemption date is reached, at which time the note is deemed to have *matured.* These transfers take place because promissory notes are bought and sold. They are normally traded at a discount, that is, at a sum less than their repayment value and depending on prevailing rates of interest and the date of redemption. People buy these notes as a way of making short-term loans. The difference between the buying price and the selling price represents interest on their money.

Upon maturity, the holder may present the note to the maker and demand payment. Should the maker fail to pay the sum due, the holder may look to the endorser for satisfaction by serving him or her with *notice of protest.* This offers some protection to the holder, particularly if there has been fraud, but it is not foolproof. It does not protect the holder if the assignor does not have the finances to pay the amount owing. A person therefore should take extreme care accepting a promissory note and should seek legal advice before signing any document or handing over money in exchange.

Many promissory notes are backed by *collateral* (some form of property offered as security or a guarantee of repayment of the loan). The collateral is held by the payee and returned when the note has been paid. If the maker fails to pay, the payee may sell the collateral, taking the costs of the sale and the sum due on the note before handing the balance, if any, to the maker.

Promissory notes were common at the time of the Renaissance. In recent times, they have become relatively rare because credit terms are generally offered in commercial contracts for buying and selling goods. Also, banks now provide overdraft facilities to businesses to enable them to buy materials.

**Promontory.** See **Cape.**

**Pronghorn** is a graceful, hoofed animal that lives in North America. It has a plump body, large ears, slender legs, and a short tail. Its colour ranges from light tan to reddish brown. The pronghorn has some white fur on its underparts, rump, sides of its face, and throat.

**A male pronghorn,** *above,* has branchlike horns with hard, black coverings. The animal sheds the coverings each year. Pronghorns roam open grasslands of western North America.

The *buck* (male) pronghorn is 90 to 105 centimetres tall at the shoulder and weighs from 45 to 65 kilograms. Its horns are 30 to 40 centimetres long and consist of a bony core with a black, horny covering. The pronghorn is the only animal in the world that regularly sheds its horn covering.

Pronghorns live in groups on open grassland in Canada, the western United States, and parts of Mexico. They feed on grasses and the twigs of shrubs. They depend on their keen sight to detect their chief enemies, wolves and coyotes. Pronghorns can run at a speed of up to 95 kilometres an hour for short distances. Pronghorns mate in the autumn. The *does* (females) generally bear twins in the spring.

The pronghorn looks like an antelope but is not a true antelope and has no close relatives. It has changed little from its ancestor which lived over a million years ago.

In 1908, only about 20,000 pronghorns remained. Pronghorns now number at least 250,000 and are a protected species.

**Scientific classification.** The pronghorn is the sole representative of the family Antilocapridae. It is *Antilocapra americana.*

See also **Animal** (picture: Animals of the grasslands).

**Pronoun** is a part of speech used in place of a noun. Pronouns include such words as *I, you, they, which,* and *that.* Such words provide variety in speaking and writing. The advantage of using pronouns can be seen in the following sentence: *Mrs. Allen warned Richard not to soil her new rug with the mud he had on his shoes.* Without the pronouns *her, he,* and *his,* this sentence would have to be rephrased as follows: *Mrs. Allen warned Richard not to soil Mrs. Allen's new rug with the mud Richard had on Richard's shoes.* The word that a pronoun refers to is called its *antecedent.* In the sentence about Mrs. Allen and Richard, the antecedent of *her* is *Mrs. Allen* and that of *he* and *his* is *Richard.*

Pronouns may be classified according to their use into the following types: personal, intensive and reflexive, interrogative, relative, demonstrative, and indefinite. Several pronouns appear in more than one category.

**Personal pronouns** refer to beings and objects. These pronouns have separate forms that show number, case, person, and gender. *Number* is shown by different forms for singular (*I*) and plural (*we*) pronouns. *Cases* of personal pronouns include the subjective case (*he*), objective case (*him*), and possessive case (*his*). *Person* is indicated by separate forms for first person (*I*), second person (*you*), and third person (*she*). *Genders* include masculine (*him*), feminine (*her*), and *neuter*—which means neither masculine nor feminine—(*it*).

Personal pronouns must agree with their antecedents in number, person, and gender. However, the case of a pronoun is determined by its use and position in a sentence. In the sentence *Jane liked her teacher,* the pronoun *her* agrees with its antecedent *Jane* in number (singular), person (third), and gender (feminine). But it is in the possessive case, and modifies *teacher.* The table with this article lists all the forms of personal pronouns.

**Intensive and reflexive pronouns,** such as *myself* and *yourself,* are formed by adding the suffix *-self* or *-selves* to certain forms of the personal pronoun. The suffixes are added to the possessive form of personal pronouns in the first person (*my*) and second person (*your*). The suffixes also combine with the objective form of the third-person pronouns, as in *himself, herself,* and *themselves.* The forms *hisself* and *theirselves* are considered incorrect according to standard grammar.

The intensive pronoun emphasizes the subject of a sentence: *I did it myself.* The reflexive pronoun helps to express an action that reflects upon the subject: *He considered himself lucky to win.* A reflexive pronoun should not be used as a substitute for the subject form of the pronoun. For example, *My husband and I left the house* is correct. *My husband and myself left the house* is incorrect according to standard grammar.

**Interrogative pronouns** ask questions. The interrogative pronouns are *who, which,* and *what. Which* and *what* always have the same form. *Who* has a separate form for each case: *Who came?* (subjective), *Whom did you telephone?* (objective), and *Whose work is this?* (possessive).

**Relative pronouns**—*who, which, that,* and *what*—introduce a clause and connect the clause to the word it modifies. The case of a relative pronoun is determined by its function in the clause it introduces:

The boy who is sitting there is my son (subjective).
The boy whom you see is my son (objective).
The boy whose head is turned is my son (possessive).

The pronoun *who* refers to persons and also sometimes refers to animals and objects, depending on the sense of the sentence. *Which* refers to animals and things. For example, *Alice's essay, which won first prize, was read to the class.* The relative pronoun *that* refers to both beings and things. For example, *Show me the bird that Judy gave you.* The relative pronoun *what* is used in a neuter sense, as in *See what the book says.*

The choice between *that* and *which* may vary with the function of the clause. Clauses introduced by *that* are ordinarily *restrictive*—that is, they provide information es-

sential to the meaning of the sentence. An example is *The car that was totally wrecked was hauled away.* Clauses introduced by *which* are ordinarily *nonrestrictive.* Such clauses add information but are not essential to the meaning of the sentence: *I was able to drive my car, which was only slightly dented.*

The compound relative pronouns commonly used are *whoever, whichever,* and *whatever.* But *whoso, whosoever, whichsoever,* and *whatsoever* are rapidly disappearing from use.

**Demonstrative pronouns**—*this* and *that*—refer emphatically to particular things or actions, as in *This is expensive* or *That is dangerous.* The plural forms of these pronouns are *these* and *those.*

**Indefinite pronouns** do not indicate a definite gender. Common indefinite pronouns include *all, any, both, each, everybody, few, many, none, one, several,* and *some.* Many of these combine with the suffixes *-one, -body,* and *-thing* to form compounds. Some compounds, together with the word *else,* form such pronouns as *someone else, anybody else,* and *everything else.*

Because of changing usage, special difficulty may occur in making verbs agree in number with indefinite pronouns. Problems may also arise in making pronouns agree in number with antecedents that are indefinite pronouns. *Anything, each one, either, neither, nobody, one,* and *something* are singular. For example, *Something is happening outside. Both, few, many,* and *several* are plural. For example, *Many are willing to try.* However, *all, any, each, none,* and *some* may be singular or plural, depending upon the meaning of the sentence. Examples include *All was ready* (singular) and *All were present* (plural). In informal usage, *anybody, anyone, everybody,* and *everyone* are often followed by plural pronouns, even though the verb may be singular. *Everyone was in their place* is informal usage. *Everyone was in his place* is formal.

**Other usage.** Standard usage calls for a subject form of a pronoun after a verb of being: *It was she we elected,* not *It was her we elected.* However, in informal usage, *It's me* and *It's him* can substitute for *It is I* and *It is he.* The selection of the appropriate form often depends on the formality of the occasion.

Expressions that use *than* or *as* often cause confusion about the proper case of the noun used with these words. In the sentence *He handles a bicycle better than her,* the objective case of the pronoun *her* may appear to be correct. But it can be seen to be incorrect in terms of standard grammar if the sentence is expanded to read *He handles a bicycle better than she (handles a bicycle). She* is the subject of the unexpressed verb *handles.*

See also **Antecedent; Case; Declension; Gender.**

**Pronunciation** is the process or action of saying words. The term *pronunciation* also describes ways in which this is done. The degree of distinctness of pronunciation is called *enunciation.* Sometimes words may have more than one acceptable pronunciation. Dictionaries list acceptable pronunciations.

The pronunciation of a language varies from person to person. Some major differences in pronunciation are due to *dialects* (regional variations). Minor variations result from minute differences in the speech organs of one person compared with another.

The people of some countries recognize a certain method of pronunciation as the standard spoken form of their language. For example, the people of Japan consider the Japanese spoken in Tokyo to be the standard form of their language. In Britain, the English spoken by educated people brought up in the southeast of England is the standard. In the United States, no single standard exists. People may use many different pronunciations that are considered correct.

A foreign language can seem hard to pronounce because some of its sounds may not be found in a person's native language. For example, the pronunciation of the *r* and *th* sounds in English is difficult for native speakers of German and French because the sounds are not used in those languages. Similarly, the German *ö,* the French *u,* and the Spanish *x* have sounds that are not found in English. People must learn how to place their lips and tongue to make the new sounds of a foreign language.

**Pronunciation problems in English.** English words follow a number of complicated pronunciation rules. The majority of words follow these rules. However, English has more irregular pronunciations than many other languages have, and many occur among the most frequently used words. Largely for this reason, many people consider English a difficult language to pronounce.

Letters and combinations of letters in English often have more than one pronunciation. One reason for this is that there are only 26 letters to represent about 40 different sounds. For example, the *digraph* (two letters representing one sound) *gh* is silent in *dough,* but sounds like *f* in *cough,* a hard *g* in *ghost,* and a *p* in *hiccough.* In Spanish and Italian, the letter *a* is always pronounced using the broad *a (ah,* as in *father).* However, the English words *fat, fate, fare,* and *far* each have a different *a* sound. People must memorize pronunciations that do not follow set rules.

**Forms of the personal pronoun**

| | Singular | | | Plural | | |
|---|---|---|---|---|---|---|
| | Subjective | Possessive | Objective | Subjective | Possessive | Objective |
| First person | I | my, mine | me | we | our, ours | us |
| Second person | you | your, yours | you | you | your, yours | you |
| Third person | he | his | him | they | their, theirs | them |
| | she | her, hers | her | | | |
| | it | its | it | | | |

Another reason why rules do not apply simply and regularly to the pronunciation of English is that the language has borrowed so much from other languages. Many borrowed words follow the pronunciation rules of the language from which they came rather than the rules for native English words. For example, in most cases an *e* added to the end of a word in English is silent. Its only purpose is to make the vowel before it long. Thus, in *cape* (pronounced *kayp*) the *e* is silent, while the *a* is long. But in the word *cafe* the *e* is pronounced *ay,* while the *a* is short. *Cafe* is one of the words that English has taken from the French. The final *e* of the French word *café* has an acute accent over it, which gives it a sound similar to a long *a.*

English also has irregular pronunciations because over a period of years the sounds of many words have changed, while the spellings have remained the same. In the 1300's, for example, the words *sane* and *sanity* were both pronounced with a short *a* (as in *hat*). The sound of the *a* in *sane* soon changed to a long *a,* but the original spelling had already been established as the standard in printed materials. In another case, the original pronunciation of the digraph *oo* in all words was a long *o* (pronounced *oh*). During the 1700's, the pronunciation of *oo* changed. Some of the variations included the *oo* of *food,* the short *u* of *wood,* and the *uh* of *flood.*

The major variations in pronunciation mentioned above give rise to regional and national *accents* (see **Accent**). A dialect is a distinct form of a language that has certain words, grammatical forms, and pronunciations that are peculiar to it (that is, they belong to it as special features). Countries may be divided geographically into specific dialect areas. See **Dialect.**

**Guidance on pronunciation.** As they learn to read, children need to be taught how to pronounce words properly; that is, they need to learn to say words in a way that most people recognize as correct. The proper pronunciation of words such as *sugar* or *light* cannot be guessed from the form of the word. A teacher must explain them and a child has to memorize them. Larger words, such as *secretary* or *indigestion,* must be tackled differently.

A word like *secretary* must be broken into *syllables.* A syllable is a combination of speech sounds consisting of one *vowel* that may be preceded and sometimes followed by a *consonant* or group of consonants (see **Consonant; Vowel**). Breaking up *secretary* into *sec-re-ta-ry* makes pronunciation and reading easier.

*Stress.* In many languages, including English, not all the syllables in a word are said with the same amount of emphasis or stress. Some are said more strongly than others. In English words, syllables can carry a *main stress,* a *secondary stress,* or no stress. In the word *photographic,* the syllable *graph* has the main stress, *pho* has the secondary stress, and *to* and *ic* are unstressed. When unstressed, certain vowels, such as *a* and *o,* change to a murmured neutral vowel that pronunciation experts usually call *shwa.*

**Pronunciations in a dictionary** use one of a host of simplified spelling systems in which vowels and consonants are all said in one way only. Thus *i* is always like *i* in *hit, g* is always like *g* in *gate,* and so on. In English there are about 40 distinct speech sounds and only 26 letters to represent them. Because of this, some simplified spelling systems are forced to use a digraph to represent, say, a long *a,* as in *make* (pronounced *mayk*). Most English readers readily understand this, but foreign students of English may not. A word like *day* is pronounced *day,* but to a foreign student learning English this is not very helpful. A Spaniard, for example, would automatically pronounce *day* more like *die.*

Other systems for indicating pronunciation use accents and diacritical marks to distinguish one sound from another. In such systems, the three *a*'s in *fad, father,* and *fade* might be printed as *a* (or *ă*), *ä,* and *ā.* Many people dislike the use of accents, however, so some modern dictionaries use an internationally agreed system of signs called the *International Phonetic Alphabet* (IPA). The IPA, which was revised in 1951, uses the usual letters of the Roman alphabet together with symbols from other languages and a number of extra signs, such as ə or ʃ.

**Related articles.** See the *Pronunciation* section of the articles on each letter of the alphabet. For foreign pronunciations, see such language articles as **French language.** See also:

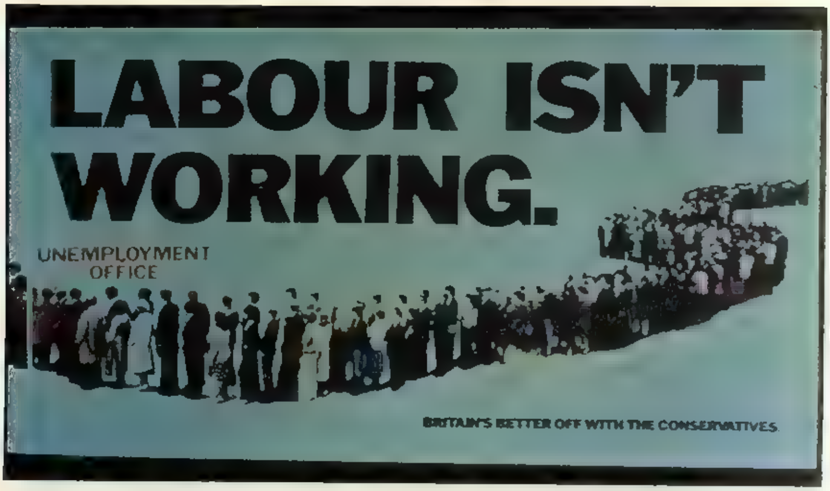
| | | |
|---|---|---|
| Accent | Homonym | Voice |
| Consonant | Phonetics | Vowel |
| Diphthong | Speech therapy | |

**Propaganda** is one-sided communication designed to influence people's thinking and actions. A television commercial or a poster urging people to vote for a political candidate might be propaganda, depending on its method of persuasion.

Propaganda differs from education in democratic societies. But education in a dictatorship can involve teaching children and youth by techniques which could be classified as propaganda. Educators in democratic societies teach people how to think, but propagandists tell them what to think. Most educators are willing to change their opinions on the basis of new evidence, but propagandists are inflexible and ignore evidence that contradicts them. Educators present all sides of an issue and encourage debate. Propagandists build the strongest case for their views and discourage discussion.

Experts disagree about what is propaganda and what is not, and whether propaganda differs from other forms of persuasion, such as advertising and political campaigning. Some look upon all slanted communication as propaganda. Others believe that the method of persuasion determines whether a message is propaganda. For example, the majority of advertisers and political campaigners function openly and state their purposes truthfully. Other advertisers and political campaigners are willing to present any combination of truths, half-truths, lies, and distortions that they think will most effectively influence their audience. Some experts say all these people are propagandists. Others regard only the second group as propagandists.

Some people consider propaganda neither good nor bad. Many favour the use of propaganda to raise money for charity. Other individuals argue that the public needs reliable information to make wise decisions, and that propaganda blocks the spreading of such information. They also fear that propaganda dulls people's minds and deadens their power of reasoning. The results of some propaganda may be short term and relatively insignificant, such as the purchase of a product. Other types of propaganda can have dangerous results.




**Political campaign slogans,** like the one on the left, might be considered propaganda when they offer an oversimplified or one-sided message.

The greatest use of propaganda occurs during wartime. At such times, government propaganda campaigns urge people to save resources, volunteer for military service, support the war effort, and make sacrifices necessary for victory. *Psychological warfare* is a type of propaganda that aims to weaken the enemy's will to fight or belief in their government. A related technique, called *brainwashing,* is used against prisoners. It combines political propaganda with harsh treatment to reduce a prisoner's resistance.

Much wartime propaganda is called *covert* (secret) *propaganda* because it comes from hidden sources. For example, a propagandist might try to discourage enemy troops by sending them counterfeit newspapers reporting huge losses among their forces. Some covert propaganda is spread by people in a country who secretly support its enemies. A group of such people is called a *fifth column.* The opposite of covert propaganda is called *overt* (open) *propaganda,* which comes from known sources.

### How propaganda works

Propaganda appeals to its audience in three ways. (1) It calls for an action or opinion that it makes seem wise and reasonable. (2) It suggests that the action or opinion is moral and right. (3) It provides a pleasant feeling, such as a sense of importance or of belonging. Political scientists use the term *triple-appeal principle* for these three techniques.

Many propaganda methods are common-sense techniques that resemble those of persuasive speaking. These techniques include (1) gaining people's trust, (2) simplicity and repetition, and (3) the use of symbols. However, propagandists often use such underhand methods as distortion, concealment, and lying. In nations ruled by dictators, governments increase the effectiveness of their propaganda by using censorship.

**Gaining people's trust.** Above all, propagandists must be believable, and their audience must consider them reliable authorities. One way to gain an audience's trust is to report unfavourable news that the audience knows or will discover. During World War II (1939-1945), the British Broadcasting Corporation (BBC) made propaganda broadcasts to Europe. The BBC began many newscasts with a report of British defeats and losses. This practice helped give the BBC a worldwide reputation for truthfulness.

Another way to gain people's trust is to agree with their existing opinions. Scientists have found that people place most trust in speakers and writers whose ideas are similar to their own. As a result, propaganda is most successful if much of it agrees with what people already believe and if only a little of it is new.

**Governments use propaganda** to promote desired behaviour among their citizens. This Chinese poster encourages people to adopt modern attitudes in industry and in education.

**Simplicity and repetition.** Propaganda must be easy to understand and to remember. As far as possible, propagandists make their appeals in simple, catchy slogans that they repeat over and over. The Nazi dictator Adolf Hitler wrote: "The intelligence of the masses is small. Their forgetfulness is great. They must be told the same thing a thousand times."

**The use of symbols** involves words and illustrations that bring strong responses from people. Individuals react not only to the actual meaning of words and the actual content of pictures but also to feelings aroused by such symbols. For example, nearly all cultures have favourable reactions to a picture of a mother and baby or to such words as *homeland* and *justice*. Propagandists try to create an association in people's minds between such symbols and their own messages. Powerful negative images are often used to increase prejudice, hostility, and hatred toward targets of propaganda.

**Distortion and concealment.** Propagandists deliberately exaggerate the importance of some facts and twist the meaning of others. They try to conceal facts that might prevent the response they seek from people. They also try to shift attention away from embarrassing facts that cannot be hidden.

**Lying.** Deliberate lying is relatively rare as a propaganda technique because propagandists fear their lies might be discovered and they might lose their audience's trust. Propaganda usually includes some accurate information. But some propagandists readily lie if they think they can deceive their audience. Propagandists may believe in their causes, but their chief goal is to shape and control the public's beliefs and actions.

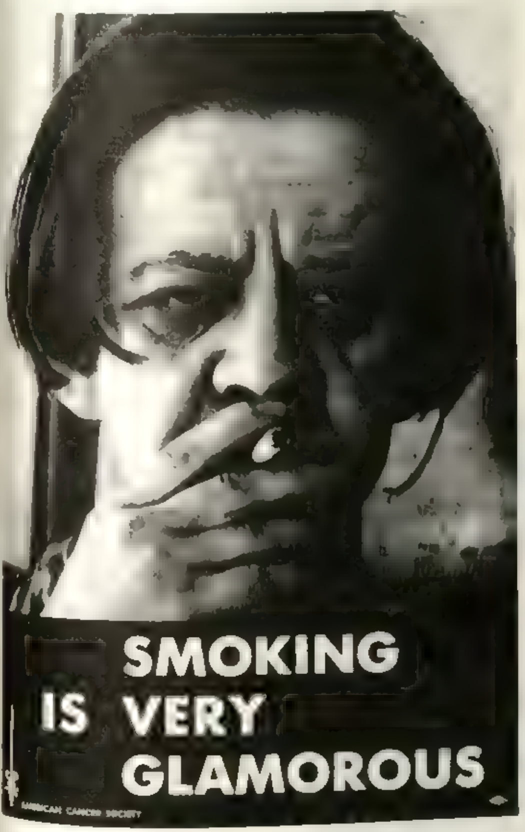
**Censorship** is most common where the government controls the newspapers, television, and other means of communication. It increases the effectiveness of propaganda because the government can silence people who contradict its official views. See **Censorship.**

### Who uses propaganda?

Propaganda comes from many sources. Three of the most important ones are (1) governments, (2) organizations, and (3) businesses.

**Governments.** Nearly all governments, including democratic ones, use propaganda to win support from other nations. Governments also sponsor propaganda and information programmes to promote desired behaviour among their own citizens. For example, government propaganda might urge people to support certain policies or to oppose foreign political systems.

**Organizations** represent members of various professions, religions, and many other fields. During election campaigns, many organizations distribute propaganda




**Advertising** uses some propaganda techniques in audience persuasion. This antismoking poster tries to create an association in people's minds between smoking and unattractiveness.

**A World War I propaganda postcard** shows the Allies—France, Russia, and Britain—as friendly soldiers united with Serbia against Austria-Hungary and Germany.


**During the Spanish Civil War** (1936-1939), this magazine cover showed a wounded man covered by a red flag, suggesting that the defeated Republicans were all Communists.

that supports candidates who agree with their views. Between elections, organizations may also use propaganda to influence public opinion. Many groups employ people called *lobbyists,* who work to persuade legislators to support their programmes. A group that tries to further its own interests by exerting pressure on legislators or other officials is often called a *pressure group.* Group members outline their goals on such controversial topics as abortion, civil rights, the environment, foreign policy issues, and nuclear energy.

**Businesses** often use propaganda in their advertising. For example, a mouthwash commercial on television might be aimed at people's desire to be attractive and popular. Advertising agencies employ psychologists and other social scientists to study why people buy certain products. They try to determine which slogans will lead to purchases. Many large businesses also have public relations departments that use propaganda to spread favourable opinions of company policies.

## History

Today, the word *propaganda* suggests shady or underhanded activity, but that was not its original meaning. The term came from the Latin name of a group of Roman Catholic cardinals, the *Congregatio de Propaganda Fide* (Congregation for the Propagation of the Faith). Pope Gregory XV established the committee—called the *propaganda* for short—in 1622 to supervise missionaries. Gradually, the word came to mean any effort to spread a belief. It acquired its present meaning after World War I (1914-1918), when writers exposed the dishonest but effective techniques that propagandists had used during the war.

Propaganda as it is used today began in the early 1900's. V. I. Lenin, who led the revolution that established Communist control of Russia, emphasized the importance of propaganda. He distinguished between two types of persuasion—propaganda and agitation. Lenin regarded propaganda as the use of historical and scientific arguments to convince the well-educated minority. He defined agitation as the use of half-truths and slogans to arouse the masses, whom he considered incapable of understanding complicated ideas. Traditionally, each Communist Party has included a unit that specializes in *agitprop*—agitation and propaganda.

**During World War I,** the Allies—including France, Great Britain, Russia, and the United States—fought the Central Powers, led by Germany. The warring nations conducted widespread propaganda operations. The major United States propaganda effort was handled by an agency called the Committee on Public Information.

**Two propaganda versions of Adolf Hitler** show the German dictator from opposite viewpoints. A pro-Hitler poster, *left,* portrays him as a heroic warrior crowned with a halo of light. An anti-Hitler cartoon, *right,* pictures him as a ridiculous, loudmouthed tyrant.

**Radio broadcasts** can be used for propaganda. The Voice of America broadcasts news and opinions around the world.

The committee distributed over 100 million posters and publications designed to increase support for the war.

**Between the wars,** several famous dictators used propaganda to help them achieve power. In 1922, Benito Mussolini established a Fascist dictatorship in Italy. Fascist propaganda promised to restore Italy to the glory of ancient Rome. Joseph Stalin, who became dictator of the Soviet Union in 1929, used propaganda and terrorism to crush all opposition. The Soviet Union had been formed under Russia's Communist leadership in 1922. In 1933, Adolf Hitler set up his Nazi dictatorship in Germany. His propaganda director, Joseph Goebbels, headed an agency called the Ministry of Propaganda and Enlightenment. The Nazis' effective use of education, films, press, and radio to shape opinion and behaviour remains one of the most famous examples of propaganda in the modern world.

**During World War II,** Germany, Italy, and Japan fought Great Britain, the Soviet Union, the United States, and the other Allies. All the major powers spread propaganda. For example, the United States Office of War Information handled overt propaganda, and the Office of Strategic Services (OSS) carried out covert operations.

**After World War II** ended in 1945, the Cold War began. The Communist nations, led by the Soviet Union, and the non-Communist nations, led by the United States, used a variety of propaganda techniques to influence world opinion, as well as their own citizens.

In 1953, the U.S. government created the U.S. Information Agency (USIA) to increase support for its foreign policy. The Voice of America, the radio division of the USIA, broadcasts entertainment, news, and propaganda throughout the world. The government has used the Central Intelligence Agency (CIA) to spread covert propaganda against governments that were unfriendly to the United States. The CIA also provided funds to establish radio networks called Radio Free Europe and Radio Liberty, which broadcast to Communist countries. The role of British intelligence services in spreading propaganda is more secret and consequently less well known. The World Service of the BBC is independent from government control and has rarely been used to broadcast propaganda, except during World War II.

**Since 1960.** In the early 1960's, China began to challenge the Soviet Union for leadership of the Communist world, and a bitter propaganda struggle developed between them. Each accused the other of betraying Communism. In the 1970's and 1980's, several Communist and non-Communist nations at times enjoyed friendlier relations and altered their propaganda operations against one another. The United States and the Soviet Union enjoyed such relations during the early 1970's and beginning again in the late 1980's. Many experts believed that the Cold War had ended, as Communists lost control in Eastern Europe and the Soviet Union. In 1991, the Soviet Union broke up into a number of independent states. However, both Radio Free Europe and Radio Liberty continued broadcasting to countries that had formerly been under Communist control, and the Voice of America also maintained its worldwide transmissions.

Propaganda is still used in many nations in Africa, Asia, Latin America, and the Middle East. In the Persian Gulf War of 1991, propaganda was used as a psychological warfare tactic by both Iraq and the U.S.-led coalition that fought against it.

**Related articles** in *World Book* include:

| | |
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| Advertising | Public opinion |
| Brainwashing | Public relations |
| Fifth column | Radio Free Europe/Radio Liberty |
| Goebbels, Joseph | World War II (Propaganda) |
| Lobbying | |
| Psychological warfare | |

**Propagation** is the breeding of plants or animals. See **Plant** (How plants reproduce); **Reproduction.**

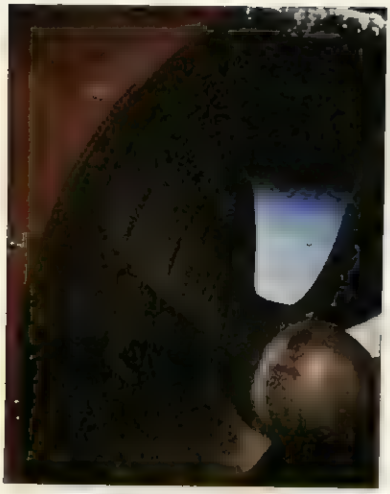
**Propane.** See **Butane and propane.**

**Propellant.** See **Space travel** (Getting into space and back); **Ammunition; Rocket.**

**Propeller** is a device for producing motion that has blades mounted on a power-driven shaft. A propeller changes an engine's power into forward thrust. The best-known types of propellers are those that drive ships and aeroplanes. A propeller's rotating blades produce a kind of force known as *aerodynamic lift* that pushes or pulls an aircraft through the air and a ship through the water (see **Aerodynamics** [Lift]). Aeroplane propellers and marine propellers work in much the same way, but they produce motion in different fluids.

The first screw propeller was developed by an American, John Fitch, in 1796 (see **Fitch, John**). His propeller was in the form of a spiral around a cylindrical rod. John Ericsson, a Swedish-American inventor, developed the first successful propeller with blades in 1836 (see **Ericsson, John**).

**Aeroplane propellers** are also known as *airscrews.* They have two or more blades. The cross-sections of the blade are aerofoil sections similar to those used in aeroplane wings. The *pitch* is the angle between the cross-section of the blade and the plane through which the propeller rotates. Propeller blades are twisted, and so the pitch changes along the length of the blade. As a result, the propeller blade meets the air at the angle that gives it the greatest efficiency. The efficiency of a propeller drops off and the noise it makes increases rap-



**Different kinds of propellers** produce the thrust that moves ships through the water and aeroplanes through the air. A typical ship propeller, *above left,* has three or more broad blades. Most aeroplane propellers have two or more narrow blades.

idly as the speed of the tips of its blades increases beyond the speed of sound.

*A fixed-pitch propeller* is one in which the angle at which the blades are set is fixed. Such propellers are efficient only at one speed of flight and for a definite power output. Fixed-pitch propellers usually are used on small aircraft.

*A constant-speed propeller* has variable pitch. The angle of the blades adjusts continuously to provide the most efficient operation at every flight speed. The propeller automatically turns the same number of revolutions per minute under all conditions of flight. It does not gain speed in dives or lose speed in climbs. This propeller is used on transport aircraft.

Many constant-speed propellers have special features that are used in emergency situations. For example, a *feathering* device enables the pilot to increase the blade angle enough to streamline the blades with the engine stopped. In case of an engine failure, the pilot can *feather,* or rotate, the blades so that their leading and trailing edges parallel the path of flight. This action decreases the propeller's air resistance and prevents possible damage to the engine.

Another feature of many constant-speed propellers is *reversible-pitch.* On such propellers, the blades can be set at a negative pitch so that the direction of the thrust is reversed. This acts as a brake and reduces the landing run on the ground. Reversible-pitch is of great value for large aeroplanes, particularly if the runways are covered with ice or snow so that the wheel brakes are not effective.

**Marine propellers** range in diameter from 25 centimetres for small boats to more than 7.5 metres for large tankers. They are usually made of manganese and bronze.

Navy ships most often have three-blade propellers, and merchant ships usually have four blades. Propellers on single-screw ships turn to the right, or clockwise, when viewed from the stern when the ship is going ahead. Twin-screw vessels usually have out-turning propellers. The starboard screw turns clockwise, and the port screw anticlockwise, for forward motion. Twin-screw ships are easily steered by reversing one of the engines while the other goes full ahead. Destroyers and other small craft can make very sharp turns in this way. Conventional propellers become less effective at high speeds because of *cavitation,* a vacuum that forms as the propeller turns. A propeller called a *supercavitating* propeller is designed so that cavitation increases the effectiveness of the propeller at high speeds.

See also **Aeroplane** (Propellers); **Screw; Ship** (The chief parts of a ship).

**Property,** in law, means ownership. It may refer to a car, a farm, a watch, or anything else that is owned. It may also refer to an interest in something that is owned by someone else, such as shares in a corporation. The corporation owns the machinery, the raw materials, and the finished products. But the shareholder is entitled to share in its profits. Property is divided into two main types. *Real property* includes land and the things permanently attached to it, such as buildings and trees. All other possessions are referred to in general as *personal property.*

Ownership of property gives a person the right of possession, use, and disposal of that property. Possession or use may be transferred to another person without losing ownership. For example, granting a lease or an easement on a piece of land gives another person the right to use the land under certain conditions. An owner of property may use it as security for a debt, such as a mortgage or a pledge. An owner who cannot pay back the debt may lose the right to the property. Property may be held in *trust* by one person for the benefit of another person.

Property interests may be acquired in several ways. People may buy property, find it, or receive it as a gift. They also may get property by a court order, as in the distribution of the estate of a person who has died without leaving a will. Not all nations permit the private ownership of, for example, land.

**Related articles** in *World Book* include:

| | |
|---|---|
| Abandonment | Estate |
| Appraisal | Mortgage |
| Assignment | Property tax |
| Attachment | Proudhon, Pierre |
| Capital | Public domain |
| Deed | Riparian rights |
| Depreciation | Title |
| Domesday Book | Trust |
| Easement | Vandalism |

**Property tax** is a tax collected from the owners of buildings, land, and other taxable property, including business equipment and inventory. Some governments also collect taxes from the owners of such property as stocks and bonds. Property taxes provide much of the income of counties, cities, and towns in many countries. Local governments depend on these taxes to help finance education, police and fire protection, street repair, and other services. Some provincial governments also collect property taxes.

In Australia, Ireland, and New Zealand, local property taxes are known as *rates.* In the mid-1980's, India introduced a tax on land and property. It was based on the government's assessment of the sale value. In the late 1980's, the United Kingdom abolished rates on domestic property, but in the 1990's replaced it with *council tax.*

The government of a community sets an annual tax rate to determine each property owner's tax bill. This rate may be a percentage of the *assessed* (estimated) value of the property. In many cases, the assessed worth is less than the property's market value.

The major problem with property taxation is that much property is not assessed fairly and uniformly. Another drawback is that assessments and rates change too slowly to keep up with changes in prices. In countries with high rates of inflation, assessments have often fallen far behind market values. Some people oppose property taxes because they believe property ownership is a poor measurement of ability to pay. But others argue that property owners are the people who benefit most from community services, and so they should pay more for these services.

See also **Education** (Financial support).

**Prophet,** in religion, is a person who claims to have been given a message by God which must be communicated to others. Early prophets were also thought to be *seers* (people who could tell the future). Often, the task of the prophet was to help people keep faith in their own traditions during times of change. Others taught the people a better way to worship God.

In Christian and Jewish tradition, the best known prophets are those whose sayings are recorded in the Bible. The magnificent poetry of many of their sayings represents a high point in Hebrew literature. The prophets of ancient Israel introduced the idea that one God ruled over all nations. The prophets spoke directly to the major leaders of their time. They urged the people to remain faithful to God and to act justly with each other.

Muslims believe that there is no people on earth who have not received a message from God through His prophets or messengers. The Quran names nearly 30 prophets, some of whom are among those recorded in the Bible, such as Elijah. Muslims believe that Muhammad was the last and greatest of the prophets.

See also **Bible** (The Old Testament) and the list of *Related articles;* **Islam** (Essential beliefs).

**Prophylaxis** means any treatment that protects a person from a disease. Prophylaxis is also called *preventive* treatment. This is in contrast to *corrective* or *curative* treatment, which is given when the patient already has a disease or unhealthy condition.

Preventive measures have been very important in improving health and prolonging life. Methods pioneered by Edward Jenner, Robert Koch, Louis Pasteur, and others proved it is possible to increase the body's immunity to certain diseases through the use of vaccines. *Collective prophylaxis* is preventive medicine in the field of public health. For example, sanitation, nutrition, and widespread immunization help protect communities from many diseases.

See also **Immune system; Jenner, Edward; Koch, Robert; Pasteur, Louis.**

**Proportion** is a relationship of equivalence between two ratios. For example, the equation $\frac{a}{b} = \frac{c}{d}$ is a proportion. The equation states that $a$ is related to $b$ in the same way that $c$ is related to $d$. It can also be written as $a{:}b = c{:}d$. Equivalent ratios are said to be *in proportion.*

In the proportion $\frac{a}{b} = \frac{c}{d}$, $a$ is called the first term; $b$, the second term; $c$, the third term; and $d$, the fourth term. The first and fourth terms are called the *extremes* of the proportion, and the second and third terms, the *means.* For all proportions, the product of the means equals the product of the extremes. For the proportion $\frac{a}{b} = \frac{c}{d}$, it is therefore true that $a \times d = b \times c$. This property of proportions provides a formal way of finding an unknown term of a proportion when the three remaining terms are known. For example, the unknown term $n$ in the proportion $\frac{9}{3} = \frac{15}{n}$ can be determined by solving the equation $9 \times n = 3 \times 15$:

$$
\begin{aligned}
9n &= 3 \times 15 \\
9n &= 45 \\
n &= 5
\end{aligned}
$$

When two ratios are in proportion, the terms of one ratio can be multiplied by a certain number to produce the terms of the other ratio. In the proportion $\frac{4}{3} = \frac{8}{6}$, for example, both terms of the ratio $\frac{4}{3}$ can be multiplied by 2 to produce $\frac{8}{6}$.

All ratios considered as numbers that are in proportion to one another equal the same number. This number is called a *constant of proportionality.* For example, the ratio of the circumference ($c$) to the diameter ($d$) of any circle is in proportion to the same ratio for any other circle. All such ratios ($\frac{c}{d}$) are equal to 3.14159. This constant of proportionality is known as *pi* ($\pi$).

The idea of proportion is the basis for many laws of astronomy, biology, chemistry, and physics. Many of these laws contain famous constants of proportionality. The idea of proportion is also used in the social sciences and the arts. Architects use it in designing scale models and drawing building plans.

**Proportional representation** is a system of electing members of a legislature. It is designed to give a political party a share of the seats in the legislature in proportion to its share of the total vote cast in an election. It also offers opportunities for candidates of minority parties to be elected. Proportional representation has three basic features: (1) three or more legislators are chosen

from each district at the same time; (2) the ballots are counted in a special way to give each political party its share of the vote; and (3) there are usually more than two active parties. These elements are present in both the *List System* and the *Hare System.*

**The List System.** Each political party offers a list of candidates for the legislature, and voters mark their ballot for the party they choose, not the individual candidates. If a party wins 40 per cent of the vote, it receives 40 per cent of the available seats in the legislature. In a campaign to fill 100 seats, the first 40 candidates on the party's list would be elected. If another party wins 20 per cent of the vote, its top 20 candidates receive seats in the legislature. The Netherlands, Belgium, and Israel are among the countries using this system.

**The Hare System,** or single transferable vote, is much more complicated. Voters number the candidates on their ballot in the order of their choice. After counting the total number of ballots, election officials determine a mathematical *election quota,* the minimum needed for election. Then they count all the first choices. A candidate who wins the quota of first choices is declared elected. All of this candidate's ballots above the quota are redistributed to the candidates chosen second by the voters. Next, the candidate with the fewest number of ballots is eliminated. This person's ballots are redistributed to the second-choice candidates listed. If the second-choice candidate has already been elected, the ballot is passed on to the third choice, and so on. This process continues until enough candidates have reached the election quota to fill all the seats. An English lawyer, Thomas Hare, described the system in 1859. The Republic of Ireland has used it since 1920.

**Propulsion, Jet.** See Jet propulsion.

**Propylaea.** See Acropolis.

**Prose** is the language of everyday speech and writing. It is also one of the two major forms of literary expression. The other is poetry. Letters and newspaper and magazine articles are written in prose. So are biographies, essays, histories, novels, and a majority of plays. Most prose, unlike much poetry, has no regular metre. Prose also lacks rhyme, which is a feature of many poems. However, prose writers often use such poetic devices as alliteration and repetition, and some writers compose highly rhythmical prose. In many cases, a reader cannot clearly distinguish between prose and poetry.

Prose styles range from simple to complex. For hundreds of years, writers and literary critics have argued about the ideal prose style. For example, Francis Bacon, an English author of the early 1600's, favoured a simple, clear, straightforward style of writing. He composed short sentences with few adjectives. On the other hand, Sir Thomas Browne, an English author of the mid-1600's, preferred to use a richer, more elegant prose style. He wrote graceful, rhythmic sentences that sounded poetic.

The King James Version of the Bible, published in 1611, combined certain features of both styles of prose. Its elegant yet natural style greatly impressed many readers. Since its publication, the King James Version has been the single most important influence on English prose writing.

During the 1900's, most prose writers have favoured a brisk, clear style and have tried to copy the rhythm and vocabulary of ordinary speech. The novels and short stories of Ernest Hemingway, an American author, are among the best examples of this style.

**Related articles** in *World Book* include:

| | | |
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| Autobiography | Drama | Fiction |
| Biography | Essay | Novel |
| Diary | Fable | Short story |

**Prose edda.** See Edda.

**Proserpina.** See Persephone.

**Prospecting** means searching for valuable mineral deposits. Prospectors have found the supplies of coal, petroleum, uranium, and other fuels that are so important to industry. They have also discovered deposits of copper, diamonds, gold, iron, and many other important minerals.

**Early prospectors** in Australia, the United States, and other countries were lured by the promise of rich discoveries of gold, silver, and other precious metals. They travelled across uninhabited regions, often on foot, carrying picks, shovels, gold pans, and other supplies. Early petroleum prospectors drilled holes in rocks looking for signs of underground oil reservoirs. Other prospectors explored deep canyons and high mountains. Most early prospectors had no scientific training, and relied chiefly on experience and luck. Most of them found only hardship and disappointment.

**Today's prospectors** must rely on the instruments and methods of the geological sciences to be successful. They must have a thorough training in mining geology and must be able to analyse the results obtained from many types of prospecting instruments. Continued extraction of mineral wealth has been possible only by digging deeper into the earth, or by finding additional hidden deposits near areas mined earlier.

Studies of known deposits help to determine the conditions under which undiscovered deposits may occur. This knowledge helps the geologist locate areas that may yield significant ore deposits. Once prospectors find such an area, they have to determine the location,

**Uranium prospectors** often use portable Geiger counters to check the amount of radioactivity in rocks and mineral deposits. Prospectors today need geological training and use geophysical instruments in discovering valuable ores.

value, and size of the buried mineral deposit. They examine surface rocks that may indicate deposits. Prospectors may also drill holes and take out specimens of rocks and fragments that can be studied to determine the value of the deposit.

Prospectors use a variety of scientific instruments. Gravity meters measure variations in the force of gravity in the deposit area. Magnetometers check the amount of magnetism in an area. Geiger counters measure the amounts of radioactive minerals in rocks (see **Geiger counter**). Ultraviolet lamps cause certain minerals to give off definite colours. In the *seismic* method of prospecting, geologists use explosives to create small earthquakes or waves in the rock. The path of these waves may be studied to indicate the conditions beneath the surface (see **Seismograph**).

Chemistry also helps the prospector locate valuable deposits of coal, copper, lead, oil, zinc, and other minerals. The presence of *trace elements* (chemical elements in very small amounts) at the ground surface may indicate large deposits under the ground. Chemical examination of rocks, plants, and water in an area may also indicate mineral deposits.

Today, most searching is done for deeply buried deposits, because most surface deposits have been discovered. Large-scale prospecting is undertaken only after careful study, because of the expensive equipment and personnel required.

See also **Geochemistry; Gold rush; Petroleum** (Exploring for petroleum); **Uranium** (Locating and mining uranium).

**Prostaglandin** is the name of a group of important chemical compounds. They are found throughout the bodies of human beings and animals. They help regulate a variety of functions, such as stomach acid production, blood pressure and body temperature, and muscle activity in such organs as the bronchi, intestines, uterus, and other body organs. They also play a major role in reproduction. Scientists have identified more than 20 prostaglandins, all of which are modified versions of fatty acids.

Prostaglandins serve as part of the body's control system. Hormones, another part of the system, carry messages from the glands to various parts of the body (see **Hormone**). Prostaglandins, on the other hand, act locally between cells. They have a role in protecting the body from certain conditions. For example, prostaglandins made in the stomach prevent ulcers. However, when a person's physical condition is impaired, prostaglandins can make things worse if produced in large amounts. This may happen when a person is in shock.

A Swedish scientist, Ulf von Enler, discovered prostaglandins in the early 1930's. But they were not *synthesized* (made) in the laboratory until the late 1960's. Since then, researchers have found how to make prostaglandin *analogues* (stable, long-acting versions of prostaglandins) and *antagonists* (chemicals that block the action of prostaglandins). They also have found that aspirin prevents the formation of prostaglandins from certain fatty acids.

Since the early 1970's, prostaglandin drugs have been used to bring on abortions or to assist childbirth in some cases. In addition, experiments show that prostaglandins—and their analogues and antagonists—might be used to treat many kinds of disorders. Such disorders include arthritis, asthma, blocked nasal passages, high blood pressure, and ulcers.

**Prostate gland** is an organ of the male reproductive system. It secretes a thick whitish fluid that helps transport sperm. All male mammals have some form of prostate gland. In men, the prostate is just below the urinary bladder and directly in front of the rectum. It weighs about 20 grams and is about the size of a chestnut. The prostate consists of muscular and glandular tissue and has a tough, fibrous surface.

Sperm is produced in the testicles and travels through two tubes to the prostate. There, the tubes connect with the *urethra,* the channel through which urine flows from the bladder and out of the body. The fluid secreted by the prostate mixes with the sperm. This fluid nourishes the sperm and helps transport it from the body through the urethra.

Abnormal enlargement of the prostate, a condition called *hyperplasia of the prostate* or *benign enlargement of the prostate,* is common among men over 50 years of age. An enlarged prostate can press on the urethra. Such pressure can make the passing of urine from the body difficult and may result in bladder infection or kidney damage. In many cases, treatment includes the surgical removal of part or all of the prostate.

Cancer of the prostate may also strike older men. In most cases, it spreads from the prostate to other parts of the body before being detected. The cancer is stimulated by the male hormone *testosterone,* which is produced by the testicles. If the cancer has spread widely, doctors treat it with female hormones or by *castration* (removing the testicles surgically). If the cancer has not spread beyond the prostate, the diseased tissue is removed.

See also **Reproduction** (diagram: Human reproduction).

**Prosthetics** is a branch of medicine that deals with supplying artificial parts for the body. An artificial part, called a *prosthesis,* replaces a body part lost as the result of injury, disease, or a birth defect. A prosthesis serves one or more of three basic purposes. (1) It duplicates, as well as possible, the functions of the missing part. (2) It provides structural support for remaining tissues. (3) It improves the person's appearance. A set of false teeth is an example of a prosthesis that serves all three purposes.

Replacement parts for the face and head are called *maxillo-facial prostheses.* Many such prostheses are for cosmetic purposes, such as replacing a missing eye or rebuilding a damaged nose or outer ear. Another type of cosmetic prosthesis, the artificial breast, is used by many women who have had a breast removed because of cancer.

A limb prosthesis provides a functional—and in some cases, cosmetic—substitute for a missing arm or leg. Diseased or damaged joints, particularly of the hip, knee, and elbow, may be replaced by functional prostheses made of metal and plastic.

Some prostheses are implanted deep within the body. For example, synthetic arteries and veins replace blocked or ruptured blood vessels. People with heart disease may receive artificial heart valves in place of faulty ones.

Some prosthetic devices perform the function of a defective body part but do not replace the part itself. For example, an implanted electronic mechanism called a *pacemaker* regulates the beating of the heart. Other devices replace an internal organ but are attached from outside the body. One such device is a *dialysis machine,* which does the work of the kidneys.

See also **Artificial limb; Dentistry** (Prosthodontics).

**Prostitution** is the performance of sexual acts for payment. It exists to meet the desires of many people who cannot find sexual satisfaction in other ways.

Prostitution exists throughout the world. Almost all prostitutes are women, but some are men. In most societies, men have more sexual freedom than women have. As a result, these societies have a shortage of female sexual partners, and prostitutes serve as a means of satisfying male sexual desires. A small number of prostitutes engage in homosexual activities.

Many social scientists believe that women become prostitutes largely for economic reasons, though other social and psychological causes also play a role. In this view, women become prostitutes because of the lure of quick financial gain not easily available elsewhere. The women's attitudes toward sexual behaviour also are important in this choice. Much prostitution is linked with such social problems as drug use. Women may turn to or stay in prostitution to pay for their drug habit.

Prostitution is legal in some parts of South America and the Far East. A few European cities have experimented with legal prostitution. Hamburg, Germany, for example, has a section set aside for prostitution. Elsewhere in Europe, prostitution is tolerated to a varying extent. In the United States, prostitution has been illegal in most states since 1915.

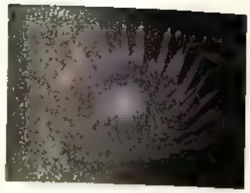
People in Western countries disagree on whether prostitution should be legalized. Many who oppose the legalization of prostitution object to the possible ties of prostitution to venereal disease and organized crime. Supporters argue that legalization of prostitution enables the government to encourage medical inspection among prostitutes for venereal disease, and to try to control the link to crime.

Prostitution has existed throughout written history. It was widespread in ancient Egypt, Greece, Rome, and China. Some prostitutes in ancient Greece had high social rank and considerable influence. The people of some ancient civilizations associated certain prostitutes with religious activities.

**Protactinium** is a chemical element. It is a radioactive metal belonging to the actinide series of elements. Two teams of scientists independently isolated the element in 1917. These were Otto Hahn and Lise Meitner of Germany, and Frederick Soddy and John Cranston of Great Britain. Protactinium occurs naturally in all uranium ores. It is also produced artificially in nuclear reactors and in particle accelerators.

Protactinium has the symbol Pa. Its atomic number is 91, and its atomic weight is 231.036. Its most stable isotope has a half-life of 33,000 years. Several chemical compounds containing protactinium are known. Protactinium metal melts at 1572° C.

**Protea** is the name of a large group of shrubs and trees that grow mainly in South Africa. Proteas have evergreen leaves and dense clusters of flowers. Each cluster is surrounded by a group of brightly coloured leaves called a bract. Proteas produce nuts which are covered in coarse hairs.



**Proteas of South Africa.** The giant protea, *left,* is the national flower of South Africa. Its flowers measure up to 30 centimetres across. The ray-flowered protea, *above,* grows as a bush up to 3 metres high.

Some *species* (types) of Protea are cultivated. In cooler countries these are normally grown in greenhouses, but they can sometimes be grown outside in areas free of frost.

The *giant protea,* or king protea, is the national flower of South Africa. The *honey protea* was used by the early European settlers in South Africa to make a syrup used to treat colds. Nectar that bees collect from the honey protea makes very good honey.

**Scientific classification.** Proteas are members of the Protea family, Proteaceae, genus *Protea.* The giant protea is *P. cynaroides;* the honey protea is *P. mellifera.*

**Protection of wildlife.** See **Wildlife conservation; Bird** (Bird study and protection).

**Protective coloration** is colouring that protects a plant or animal from its enemies. There are several forms of protective coloration that deceive enemies or warn them away.

In *cryptic coloration,* the colour and colour pattern of a plant or animal blend in with the surroundings so that the individual is not easily discovered. For example, the coloration of many insects, reptiles, birds, and mammals that live in the desert closely matches the colour of the sand. The stone plants of South Africa look like stones. Snowshoe hares and weasels have coats of brown hair during warm months and white coats during the winter months.

In *disruptive coloration,* one part of an animal's body stands out more than the other parts so that the real shape of the body is not conspicuous. For example, the killdeer, a bird that lives in fields in North America, has a bold pattern of brown-and-white crossed with black stripes. An enemy sees several brownish lumps and may not recognize the outline of the bird.

*Mimicry* is a form of protective coloration in which a plant or animal strongly resembles another plant or animal. *Batesian mimicry* occurs when an animal that is otherwise defenceless against a particular enemy looks like an animal that is distasteful or dangerous to that enemy. For example, the viceroy butterfly has a colour pattern similar to that of the monarch butterfly, which makes birds sick when eaten.

Another form of protective coloration is called *warning coloration.* A number of brightly coloured insects,

such as ladybirds and bumble bees, taste bad or sting. Their warning coloration reminds a predator of past experiences with those insects and frightens it away.

Protective coloration has been developed over many thousands of years. Plants and animals protected by colour survived and reproduced their kind. Those that were not protected died out. This process is called *natural selection.*

**Related articles** in *World Book* include:

Animal (Animal defences; picture: Animal camouflage)
Bird (Protection against enemies; pictures: Protective coloration)
Butterfly (How butterflies protect themselves; picture)
Fish (Skin and colour)
Flounder
Mimicry

**Protective resemblance.** See Mimicry.

**Protective tariff.** See Tariff.

**Protectorate** is a weak country that is controlled by a stronger country. Protectorates usually have a certain amount of self-government, but the "protecting" nation has the final voice in important matters. The protecting power conducts all foreign relations for the protectorate and supervises the protectorate's defence.

In British history, the Protectorate (1653-1659) was the period during which Oliver Cromwell ruled England as lord protector. His son, Richard, succeeded him as lord protector in 1658.

**Protein** is one of the three main classes of foods essential to the body. The others are carbohydrates and fats. Proteins exist in every cell and are essential to plant and animal life. Plants build proteins from materials in the air and the soil. Human beings and animals obtain proteins from the foods they eat. Foods that are high in protein content include cheese, eggs, fish, meat, and milk.

**The structure of proteins.** All proteins contain carbon, hydrogen, nitrogen, and oxygen. Some proteins also contain iron, phosphorus, and sulphur. Proteins are large, complex molecules made up of smaller units called *amino acids.* The amino acids are linked together into long chains called *polypeptides.* A few polypeptides are straight, but most are bent into complex three-dimensional shapes. A protein consists of one or more polypeptide chains.

Twenty amino acids are assembled into the thousands of different proteins required by the human body. To assemble the proteins it needs, the body must have a sufficient supply of all these amino acids. Some amino acids, called *essential amino acids,* cannot be produced by the body and must be supplied by various foods. Adults and children require eight essential amino acids, and infants need nine. The remaining amino acids, called *nonessential amino acids,* can be manufactured by the body itself.

**Some forms of protective coloration**

**Cryptic coloration** allows ptarmigans to blend into their snowy surroundings.

**Warning coloration** protects a skunk by reminding the animal's enemies of its ability to spray a foul-smelling liquid.

**Batesian mimicry** occurs when an otherwise defenceless animal resembles one that is feared or avoided. For example, the flower fly, *left,* looks much like the bumble bee, *right.*

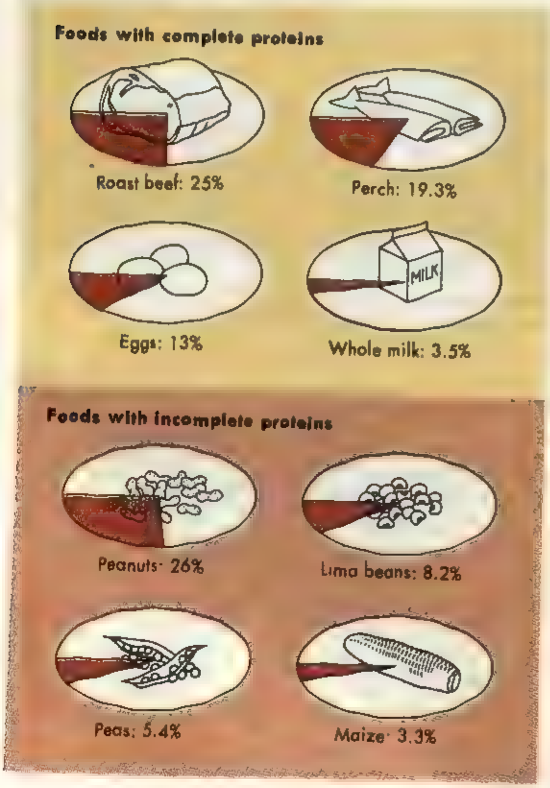
**Proteins in the diet.** The best sources of proteins are cheese, eggs, fish, meat, and milk. The proteins in these foods are called *complete proteins* because they contain adequate amounts of all the essential amino acids. Cereal grains, *legumes* (plants of the pea family), nuts, and vegetables also supply proteins. These proteins are called *incomplete proteins* because they lack adequate amounts of one or more of the essential amino acids. However, a combination of two incomplete proteins can provide a complete amino acid mixture. To do so, each incomplete protein must have sufficient amounts of the essential amino acids of which the other incomplete protein contains small amounts. For example, a cereal grain, such as barley or wheat, could be combined with a legume, such as peas or peanuts. The foods must be eaten together to provide the correct balance of amino acids.

Infants and children need extra protein, as do pregnant women and nursing mothers.

Insufficient protein in the diet may cause lack of energy, stunted growth, and lowered resistance to disease. A protein shortage also may lead to *oedema*, a condition in which fluids accumulate in body tissues, causing the tissues to swell. In developing countries, many infants and children have a disease called *kwashiorkor* as a result of eating little or no food containing complete proteins. Severe cases may cause liver damage and eventual death. See **Kwashiorkor**.

**Protein content of selected foods**

Foods vary in the amount and kind of protein they contain. Those with *complete proteins* provide enough of all the essential amino acids. Foods with *incomplete proteins* lack enough of one or more of these amino acids. But correct combinations of incomplete proteins can provide a balanced amino acid mixture.




**How the body uses proteins.** Proteins make up a large part of each cell in the human body. Therefore, they are important in building, maintaining, and repairing body tissues, especially bone, cartilage and muscle. In addition, every cell contains proteins called *enzymes*, which speed up chemical reactions. Without enzymes, the cells could not function. Certain proteins perform specific jobs. For example, the blood contains such proteins as *albumin* and *haemoglobin*. Albumin helps maintain the body's fluid balance by keeping water in the blood. Haemoglobin carries oxygen from the lungs to body tissues. *Antibodies* are proteins in the blood that help protect the body from disease. Chemical substances called *hormones*, many of which are proteins, control such processes as growth, development, and reproduction.

The body obtains most of its energy from carbohydrates and fats. However, the body uses proteins for energy when carbohydrates and fats cannot meet its energy needs. Proteins produce about 4 calories of energy per gram, the same amount provided by carbohydrates.

After proteins have been eaten, hydrochloric acid in the stomach causes the protein molecules to *coagulate* (thicken and clump together). Enzymes in the stomach and in the intestines break down the coagulated proteins into individual amino acids. The amino acids are absorbed into the blood and travel throughout the body. Every cell in the body assembles the amino acids into the proteins it needs. This process is controlled by *DNA* (deoxyribonucleic acid), a substance in the nucleus of each cell. For a detailed description of how a cell produces proteins, see Cell (Producing proteins; The code of life).

Food containing proteins should be included in the daily diet because the body cannot store proteins for later use. The body converts excess proteins into carbohydrates and fats. If the body does not receive enough proteins from the food eaten, it uses proteins from the cells of liver and muscle tissues. However, continued use of such proteins by the body can permanently damage those tissues.

**Related articles** in *World Book* include:

Albumin
Amino acid
Cheese
Egg
Enzyme
Food supply (Protein)
Gelatin
Gluten
Heredity (Chemical basis)
Interferon
Life
Milk (Nutrients in milk)
Nutrition

**Protein-calorie malnutrition.** See Nutrition (Protein-calorie malnutrition).

**Proterozoic Era.** See Earth (The earth's earliest history).

**Protest.** See Civil disobedience; Civil rights; Riot.

**Protestant Episcopal Church.** See Episcopal Church.

**Protestant ethic** is a set of attitudes that stress the moral value of work, self-discipline, and personal responsibility. These principles developed from the Protestant belief that people do not live and work for themselves alone. People's work—or their *calling*, as it is

sometimes termed—comes from God. People prove their worth to themselves, to their society, and to God by overcoming hardship through dedicated achievement, self-control, and moral living.

The Protestant ethic encourages people to work because of the belief that work is good. The ethic emphasizes self-denial to promote thrift, and it discourages spending large amounts of money on luxuries or personal pleasures. It also holds that unnecessary comforts distract people from their duty to God. The Protestant ethic does not view wealth as evil in itself. Wealth becomes evil only when it tempts people to idleness and sinfulness.

Personal responsibility ranks as one of the most important ideals of the Protestant ethic. For example, dedication, foresight, and thoughtfulness help a person succeed. The ability to resist temptation keeps a person from wasting energy, savings, and time. According to the Protestant ethic, a person is good if he or she is hard-working, honest, and thrifty. Such a person is more virtuous than one who is lazy, pleasure-seeking, and wasteful.

The concept of the Protestant ethic is closely associated with Max Weber, a German sociologist. In 1904 and 1905, Weber wrote a famous essay called "The Protestant Ethic and the Spirit of Capitalism." He maintained in this essay that the principles of the Protestant ethic contributed to the development of the economic system called *capitalism*. In capitalism, individuals and corporations control and direct the means of production. The hard work, investments, and savings of individuals help build a capitalist economy.

See also **Weber, Max; Reformation** (Political and social influences).

**Protestantism** is the general name for hundreds of Christian denominations and sects that differ slightly or greatly from one another. About 420 million people—about 8 per cent of the world's population—belong to these various groups. Among Christian bodies, only the Roman Catholic Church has more members.

Protestantism resulted chiefly from the Reformation, a religious and political movement that began in Europe in 1517. The word *Protestant* comes from the Latin word *protestans,* which means *one who protests.* It was first used in 1529 at a *Diet* (special assembly) in Speyer, Germany. At the Diet, several German leaders protested against an attempt by Roman Catholics to limit the practice of Lutheranism, an early Protestant movement. The leaders became known as Protestants because of their protest. The name Protestants soon came to include all of the Western Christians who had left the Roman Catholic Church.

Most Protestants live in Europe and North America. A Protestant denomination is the state religion of a number of nations, including Denmark, Great Britain, Norway, and Sweden. Protestantism has strongly influenced the cultural, political, and social history of these and other countries.

### Protestant beliefs

Protestants share certain Christian beliefs with members of the Roman Catholic and Eastern Orthodox churches. For example, Protestants believe there is only one God. Most members of Protestant denominations also believe that in God there are three Persons who together form the *Trinity.* These Persons are the Father; the Son, who is Jesus Christ; and the Holy Spirit. Protestants also believe in the central importance of Christ as the saviour of humanity.

Protestants disagree with other Christians about the relationship between humanity and God. As a result of this disagreement, certain Protestant beliefs differ from those of other Christians. These beliefs involve (1) the nature of faith and grace and (2) the authority of the Bible.

**Faith and grace.** Protestants oppose the Roman Catholic doctrine on salvation. Catholics believe that people achieve salvation by having faith in God's grace and by their own merit—that is, by doing good works. However, Protestants think this belief in human merit makes people too important in their relationship with God. They also believe it demands too much of humanity because people cannot know when they have done enough to please God. Protestants stress the importance of faith and reject the emphasis that Catholics place on good works.

According to Protestantism, God is gracious—that is, He is loving and forgiving. He establishes and is responsible for His relationship with people. Protestants believe people are incapable of saving themselves because of their sins. Therefore, they are saved by the grace of God and not by their own merit. Protestants believe this grace of God comes to people through Christ. They regard Christ's death on the cross as a gift of God's grace. But this grace comes to those who have faith, not to those who do good works. Thus, people receive salvation by having faith in God's grace, which comes to them through Christ.

**The authority of the Bible.** The beliefs of Roman Catholics are based on both the Bible and the traditions of their church. These traditions come from the declarations of church councils and popes. They also come from short statements called *creeds* and from longer, formal statements called *dogmas.* Most Protestants, on the other hand, believe that the Bible should be the only authority for their religion.

Through the centuries, several Protestant denominations have based their beliefs on other authorities in addition to the Bible. For example, certain churches believe that personal religious experience serves as a measure of their faith. Others believe they can test their faith through human reason or certain church traditions. But in general, the Bible remains the central religious authority for Protestants.

### Worship and liturgy

Protestants worship only one God. But various denominations worship Him in greatly different ways. Protestant *liturgies* (worship services) range from the simple, informal meetings of the Quakers to the elaborate ceremonies of certain Anglican churches. But despite many differences, most Protestant liturgies share such basic features as (1) faith in the word of God, (2) belief in sacraments, and (3) the importance of the laity.

**Faith in the word of God.** Most Protestant liturgies stress preaching and hearing the word of God. Protestants believe that God is present in their midst and inspires faith in them when they discuss, hear, and read

the Bible. For this reason, most Protestant services focus attention on the preacher and the sermon.

**Belief in sacraments.** Various Protestant denominations disagree about the nature and number of solemn observances called *sacraments.* But most denominations include at least two sacraments—Baptism and the Lord's Supper—in their worship.

Baptism is a ceremony that represents either the beginning of the Christian life or a sign of a person's faith. Most Protestants connect baptism with a gift of faith and grace from God.

The Lord's Supper, or Communion, is a ceremony that reenacts or recalls Christ's words and actions at the Last Supper. Most Protestants believe it represents God's forgiveness of sinners.

**The importance of the laity.** Most Protestant churches stress the role of the *laity,* church members who are not clergy. Protestantism encourages these people to take part in the liturgy through singing and prayer. Such participation establishes a sense of community in which God's word may be heard and His relationship to humanity understood.

Many Protestant churches encourage the *ordination* of women members of the congregation. Through ordination, women can become members of the clergy. This was not a practice of the early Christian Church, but is seen to reflect the position of women in society today.

### History

Most Protestant denominations originated during the Reformation. But some, such as the Moravian Church, had been established before this. The Reformation was the culmination of a period of renewal in the Roman Catholic Church, during which scholars closely examined their Christian faith. One of the first changes that this renewal brought about was the translation of the Bible from Latin into the *vernacular* (the language of the people). The first translation of the Bible into English was by John Wycliffe in the late 1300's. This and other translations made Christian teaching more easily available to many people and led to a desire to return to the simplicity and Christian values of the early Church.

The Reformation itself began in 1517, when Martin Luther, a German monk, protested against certain practices of the Roman Catholic Church. By about 1550, Protestantism had spread throughout almost half of Europe. See **Reformation; Roman Catholic Church** (The Reformation and Counter Reformation).

Protestantism developed as a series of semi-independent religious movements. These movements resembled one another in their rejection of the central authority of the pope. But cultural, geographic, political, and religious differences caused them to develop independently in varying degrees. Many such differences resulted in the division of a movement into various denominations and sects.

Despite their differences, the various Protestant movements can be divided historically into five general groups. These groups are (1) the conservative reform movements, (2) the radical reform movements, (3) the free church movements, (4) the Methodist movement, and (5) the unity movement.

**The conservative reform movements (the 1500's).** These movements include groups that broke away from the Roman Catholic Church but kept many basic beliefs of that church. Among such movements, in order of their establishment, are the Lutheran; the Reformed, or Presbyterian; and the Anglican, or Episcopalian.

The Lutheran movement, based on the teachings of Martin Luther, was the earliest major Protestant movement. It spread rapidly throughout northern Germany and the Scandinavian nations during the 1520's. Lutherans largely agreed on the importance of faith and the authority of the Bible. But they disagreed widely over the form of the liturgy and church government. These disagreements led to the formation of several denominations.

The Reformed, or Presbyterian, movement developed largely from the teachings of two reformers, Huldreich Zwingli and John Calvin. During the 1520's, Zwingli, a Swiss priest, urged reforms that were more radical than Luther's. In the 1530's, the French reformer John Calvin largely combined the ideas of Luther and Zwingli. Calvin's teachings strongly influenced people in England, France, the Netherlands, and Scotland. In England, many of his followers became known as *Puritans.* In France, they were called *Huguenots.* The Scottish reformer John Knox introduced Calvin's teachings in Scotland.

The Anglican, or Episcopalian, movement started in England. It resulted from the Act of Supremacy of 1534, in which King Henry VIII declared his independence from the pope. The king became the supreme head of the church in England, but he remained a Roman Catholic. Protestant ideals were not at first encouraged. However, after the break from Rome, he ordered an English translation of the Bible to be placed in every church. The Anglican Church became established in England only after much dispute and bloodshed. In 1559, Queen Elizabeth I established a moderate form of Protestantism that became known as Anglicanism.

**The radical reform movements (the 1500's and 1600's).** Some small religious sects differed widely from both the Roman Catholic Church and major Protestant churches. Most of these radical groups believed that conservative Protestants had not gone far enough in reforming the Catholic Church. Many of the sects rejected conservative reforms and developed their own forms of worship.

The Anabaptists and other radical groups first appeared during the Reformation. Other radical sects developed in Europe and North America after the Reformation. They included the Quakers, the Separatists, and the Shakers.

**The free church movements (the 1500's and 1600's).** This group consisted of two movements, the Congregational and the Baptist. They developed chiefly from Puritan churches that had been established during the Reformation.

During the late 1500's in England, various Puritans opposed certain policies of the Anglican Church. They believed they could not reform the church from within, and so they separated from it. This separation resulted in their being called *Separatists.* But they soon became known as *Congregationalists* because of their belief in the rights of local congregations.

In the early 1600's, an English clergyman named John Smyth led a group of Separatists to the Netherlands. He and his followers believed that only people who were

old enough to express their faith should be baptized. Smyth's group became known as *Baptists.*

The free church movements spread into colonial America. The Pilgrims, a separatist group led by William Brewster, established the Plymouth Colony in 1620. In 1638, the religious leader Roger Williams founded a Baptist church in Providence in the Rhode Island Colony. By the 1920's, the Baptist Church ranked as the largest Protestant denomination in the United States.

**The Methodist movement (the 1700's).** Methodism developed largely from *pietism,* a religious attitude that began in Europe during the late 1600's. Pietism stressed the importance of personal devotion and morality as the most profound expressions of faith.

In the early 1700's, John Wesley, an English clergyman, set out to reform the Anglican Church, also known as the Church of England. Wesley preached doctrines that were *evangelical*—that is, they emphasized the need for personal religious experience. He was not satisfied by the Anglican response to his reform and, in 1744, he organized the Methodist movement. Methodism grew rapidly in England and, later, the movement spread to the United States.

Pietism and various evangelical churches greatly influenced other Protestant denominations. Many missionary movements began, and Protestantism in different forms had spread throughout the world by 1900.

The more conservative and enthusiastic branches of Methodism gave birth to the Holiness movement, including the Nazarenes. In the early 1900's, the Holiness movement, in turn, inspired a movement called Pentecostalism. Pentecostalism has become one of the most rapidly growing forms of Protestantism. The Pentecostals are sometimes called *charismatics.*

**The unity movement (the 1800's and 1900's).** Since the mid-1800's, many Protestants and other Christians have shown an increasing desire to overcome their differences. They have sought to unite various Protestant denominations and to encourage cooperation through federations and councils. They also have worked to increase good will among Protestants and members of the Eastern Orthodox and Roman Catholic churches.

In 1846, a group in London formed the Evangelical Alliance to give individual Christians an opportunity to unite in friendship and discussion. During the early 1900's, the trend toward Christian unity became known as the *ecumenical movement.* Representatives of different Protestant denominations met with one another, as did representatives of Protestant churches and the Eastern Orthodox Churches. In 1948, church leaders founded the World Council of Churches. This organization works for cooperation and unity among all the churches of the world.

In 1965, Pope Paul VI expressed the need for unity among all Christians. He made the statement at the end of an ecumenical council called Vatican Council II. Many Protestants and other Christians welcomed the pope's expression of unity and the unifying spirit of the council itself.

**Related articles** in *World Book* include:

**The Reformation**

Anabaptists
Calvin, John
Covenanters
Cranmer, Thomas
Huguenots
Hus, John
Knox, John
Latimer, Hugh
Lollards
Luther, Martin
Melancthon, Philipp
Reformation
Ridley, Nicholas
Thirty-Nine Articles
Tyndale, William
Wycliffe, John
Zwingli, Huldreich

**Later European Protestantism**

Arminius, Jacobus
Barth, Karl
Bonhoeffer, Dietrich
Booth, William
Fox, George
Oxford Movement
Tillich, Paul
Watts, Isaac
Wesley, Charles
Wesley, John
Whitefield, George
Wilberforce, Samuel

**American Protestantism**

Asbury, Francis
Channing, William Ellery
Cotton, John
Eddy, Mary Baker
Fundamentalism
Graham, Billy
Hutchinson, Anne
Mather (family)
Moody, Dwight L.
Muhlenberg (family)
Penn, William
Puritans
Revivalism
Williams, Roger
Wise, John

**Protestant churches and groups**

See **Anglicans; Baptists; Lutherans; Methodists; Presbyterians;** and their related articles.

See also:

Adventists
Amanites
Amish
Assemblies of God
Brethren
Christian Scientists
Congregationalists
Doukhobors
Hutterites
Jehovah's Witnesses
Mennonites
Moravian Church
Pentecostal churches
Quakers
Seventh-Day Adventists
Shakers
Swedenborgians
Unitarians
United Church of Christ

**Protestant organizations**

Gideons International
Salvation Army
World Council of Churches
Young Men's Christian Association
Young Women's Christian Association

**Other related articles**

Protestant ethic
Religious life (Protestant churches)
Roman Catholic Church (The Reformation and Counter Reformation)

**Protist** is the name of a group of organisms, most of which are microscopic. The group consists chiefly of such one-celled organisms as diatoms, protozoans, and certain algae. Protists make up the Protista, one of the five biological kingdoms of living organisms. The other kingdoms are Monera (monerans), Fungi (fungi), Plantae (plants), and Animalia (animals).

The German zoologist Ernst Haeckel first proposed the idea of Protista in 1866. He included the organisms fungi and sponges in the group. Today, many biologists limit the kingdom to one-celled organisms that have a well-defined nucleus and typical *organelles.* Organelles are structures that perform certain functions. Many biologists classify one-celled organisms that lack a well-defined nucleus or typical organelles in the Monera kingdom (see **Moneran**). Most protists reproduce by *mitosis,* a process by which one cell divides into two separate cells. Some reproduce sexually.

See also **Algae; Diatom; Euglena; Kingdom; Protozoan.**

**Protium.** See **Hydrogen** (Properties).

**Protocol** is a document containing a record of talks carried on by diplomatic representatives. The document shows that the diplomats have agreed on important issues. A protocol is an official government paper, but it does not have the force of a treaty until ratified by the governments concerned (see **Treaty**). The term *protocol* also means the official *etiquette* (correct procedures) of state ceremonies.

**Proton** is a positively charged subatomic particle. A single proton constitutes the nucleus of an ordinary hydrogen atom. Protons, together with other subatomic particles called *neutrons,* make up the nuclei of all other atoms (see **Neutron**). All atoms of the same chemical element have the same number of protons. The number of protons in the atoms is called the *atomic number* of the element.

Ordinarily, an atom has an equal number of protons and *electrons,* negatively charged particles that surround the nucleus. Each proton carries one unit of positive electric charge, and each electron carries one unit of negative electric charge. As a result, the atom is electrically neutral.

Protons are made up of fundamental particles called *quarks* (see **Quark**). A proton has a diameter of approximately 0.000000000001 millimetre. The mass of a proton in grams may be written with a decimal point followed by 23 zeros and a 2.

The proton was first observed by the German physicist Wilhelm Wien in 1902 and rigorously identified by the British physicist Sir Joseph J. Thomson in 1906. Scientists initially believed that protons would not naturally *decay* (break down) into other particles. However, mathematical *grand unified theories,* introduced in the mid-1970's, offered new insights about the fundamental forces that affect atoms and their nuclei (see **Grand unified theories**). These theories predict that proton decay can occur, and experiments to detect this decay are underway.

See also **Atom; Baryon; Electron; Gluon.**

**Protoplasm** is a term that means the living matter of cells. The term is little used by modern biologists because it is not specific. Johannes Purkinje, a Czechoslovakian physiologist, first used it in 1839. At that time, scientists knew that all living things are made up of cells that seemed to contain a jellylike material. Purkinje named this material *protoplasm*—from Greek words meaning *first formed* or *moulded*—to indicate it was the most basic substance of life.

Since that time, more powerful microscopes and advanced biochemical techniques have revealed more about the structure of the cell. Scientists have discovered that the jellylike material of cells is actually a complex mixture of proteins and other substances. The composition of this mixture varies among different types of cells and even from one part of a cell to another. Thus, biologists today use the terms *cytoplasm, nucleoplasm,* and *plasma membrane* to describe specific parts of the living cell matter (see **Cell** [Inside a living cell]). But the word *protoplasm* is sometimes used to describe the substance of a type of slime mould lacking cell boundaries at one stage of its life cycle.

**Prototype.** See **Aeroplane** (Building an aeroplane); **Manufacturing** (Design).

**Protozoan** is a one-celled organism that may have plantlike or animallike characteristics. Scientists traditionally classified protozoans as animals and placed them in the phylum Protozoa. Today, however, many scientists group protozoans as neither animals nor plants. They place protozoans with other simple organisms in the kingdom Protista (see **Protista**). The study of protozoans is called *protozoology.*

## Characteristics of protozoans

There are more than 30,000 kinds of protozoans, most of them so small that they can be seen only through a microscope. Protozoans live in moist places. They are found in salt water, fresh water, soil, plants, and animals.

**Structure.** The *amoeba* is one of the simplest protozoans. The single cell that makes up its body carries on all the necessary life processes by itself. The cell eats, breathes, and responds to its surroundings.

Other protozoans are more complicated in structure. Some of them, called *ciliates,* have tiny hairlike projections that help them move about. The *paramecium* has a definite groove on one side that serves as a mouth.

Some protozoans have a bright red spot called the *eyespot.* This spot may be sensitive to light.

The bodies of some protozoans contain chlorophyll, the green substance also found in plants. Chlorophyll enables these protozoans to make their own food (see **Photosynthesis**).

**Reproduction.** Some protozoans reproduce by a process called *fission.* In this process, the original cell splits in two. Each half of the original cell becomes a separate individual. In other protozoans, the parent cell suddenly swells in one direction. The swollen part breaks off and forms a new protozoan. This process is called *budding.* Certain protozoans reproduce by dividing into many cells called *spores.* Other protozoans show the beginnings of sexual reproduction. In all these forms of reproduction, the cell's nucleus is divided among the new individuals. See **Reproduction.**

**Importance.** In spite of their small size, protozoans are very useful for both human beings and animals. Millions of protozoans swim in the sea, where they are eaten by sea animals. Some protozoans, such as the foraminifers, are covered with stony shells. When they die, they settle to the bottom of the sea and contribute to the formation of limestone. The fossil shells of such protozoans are partly responsible for the chalk cliffs that are found in southern England.

Many protozoans are serious enemies of human beings and animals. Malaria and African sleeping sickness are among the diseases they cause.

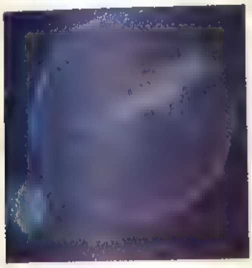
## Types of protozoans

Protozoans can be divided into four groups on the basis of how they move about. These groups are (1) flagellates, (2) sarcodines, (3) apicomplexans, and (4) ciliates.

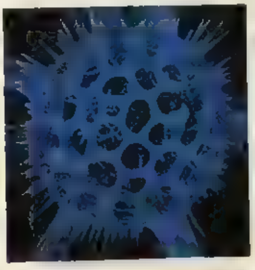
**Flagellates** have one or more long hairlike projections from their bodies called *flagella.* The flagella whip about rapidly to move the flagellate through the water. Flagellates are usually oval in shape, and many have chlorophyll in their bodies. The green *euglena* is shaped much like a submarine. It is common in fresh water. The *volvox* is a green ball of flagellated cells that live together. This ball moves about when the flagella of the

### Types of protozoans

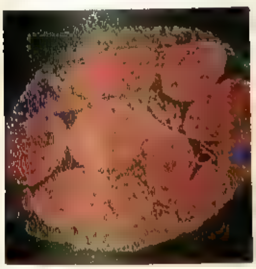
Protozoans can be placed into four groups on the basis of how they move: (1) flagellates, which have one or more whiplike *flagella*; (2) sarcodines, which include the amoebalike protozoans; (3) apicomplexans, which move by gliding; and (4) ciliates, which have many hairlike *cilia*.



**A flagellate**



**A sarcodine**



**An apicomplexan**

**A ciliate**

individual members that make it up are whipped in the water. The *trypanosomes,* which cause African sleeping sickness, are also flagellates.

**Sarcodines** move by extending fingerlike *pseudopods* (false feet). A sarcodine forms these structures by pushing out its membrane. Sarcodines also use pseudopods to capture food. Sarcodines include various protozoans that resemble amoebas. Many of these amoebalike protozoans live in the bodies of human beings and animals. Some cause disease and others do not. For example, the harmless colon amoeba is found in the large intestine of many healthy people.

*Radiolaria* are among this group of amoebalike protozoans. Radiolarians have a tiny skeleton that is made of silica. After a radiolarian dies, this skeleton sinks to the sea floor. Millions of shells have accumulated in parts of the sea, forming thick layers of ooze. The *foraminifers* have shells made of chalklike material. Some of the ancient foraminifers were as large as 20 centimetres in diameter. Geologists seeking oil study foraminifer fossil shells in rocks found below the surface. They indicate how the earth layers are arranged.

**Apicomplexans** make up a special group of protozoans that move by gliding. They live as parasites. The malarial parasite is a well-known apicomplexan.

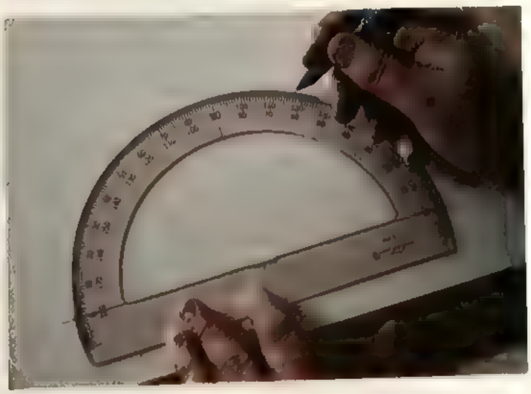
**Ciliates** are the most complex protozoans. All of them have, at one time or another, fine hairlike projections, which are called *cilia*. The cilia help the ciliates move about to capture food. The *stentors,* which are shaped something like a horn or trumpet, rank among the largest of all of the protozoans. Another kind of ciliate, the *vorticella,* looks something like a funnel with a long tube. The vorticella creates a little whirlpool around the top of the funnel to draw food into its body.

**Related articles** in *World Book* include:

| | | | |
|---|---|---|---|
| Amoeba | Cilia | Nummulite | Trypanosome |
| Cell | Euglena | Paramecium | |

**Protozoology.** See **Protozoan.**

**Protractor** is a device for measuring the size of angles. Protractors are made of plastic, paper, or metal. They are usually a semicircle. The angles from 0 to 180 degrees (or, occasionally, from 0 to 3200 mils) are printed or cut on them. The bottom edge is placed along one line of the angle. The reading is made where the other line crosses the scale.



**A student uses a protractor to measure angles.**

Plane protractors lie flat on the work on the drawing board. One plane protractor can measure all the angles on any size of board. A spherical protractor, used in astronomy and navigation, indicates measurements of spherical angles and is made of paper or plastic bent into the arc of a sphere. Only one size of sphere can be used with a spherical protractor.

See also **Technical drawing.**

**Protura.** See **Insect** (table).

**Proudhon, Pierre Joseph** (1809-1865), was a French socialist and reformer. In 1837, he published his *Essai de Grammaire Générale.* This work won him a three-year pension from the Academy of Besançon. But three years later, his *What Is Property?* lost him the academy's approval. It revealed his socialist ideas, and stated that "property is theft."

Proudhon wrote many other works. His literary and political activities often led to trouble with the French government. He spent a number of years in prison and in exile. His work is not always consistent and is sometimes difficult to interpret, because of his love for paradoxical and extreme phrases. He condemned ownership of property, for example, but did not condemn peasant proprietors who neither abused their land nor used it as a source of revenue from others.

**Political ideas.** Proudhon was enthusiastic about the ideas of liberty, justice, and equality. His idea of liberty implied the rejection of all authority, except for that in the family. Unlike many other socialist writers, he had little use for the powers of government. He had contempt for representative government and democracy. He was

an *anarchist,* or a believer in a social order without government (see **Anarchism**).

Proudhon argued that society should operate by means of contracts. These contracts should be voluntary agreements among free and equal peoples. He believed that contracts would establish a system of mutual rights and duties, which would result in justice. He urged equality, but was inconsistent in this. He believed in the existence of inferior races, and opposed giving greater political and social rights to women.

**Economic beliefs.** Proudhon advocated free credit, and founded the People's Bank to carry out his ideas about finance. The bank gained about 27,000 subscribers, but Proudhon was forced to liquidate it after a few months, because of political difficulties.

In some of his works, Proudhon favoured cooperation between working people and small proprietors. Such cooperation, he believed, would be more likely to bring about liberty, justice, and equality than would any action by the government.

**Early life.** Proudhon was born at Besançon, and studied at the College of Besançon. From 1843 to 1847, he worked in a printing plant in Lyon. He moved to Paris in 1848.

**Proust, Joseph Louis** (1754-1826), was a French chemist. He became known for supporting the idea that every pure chemical compound consists of elements in a definite proportion. Scientists now accept this idea as the *law of constant proportions.*

In Proust's day, Claude L. Berthollet, an influential French chemist, disagreed with him. Berthollet believed that the proportion of elements in a compound could vary. The chemists debated their views for years, until Proust's experimental evidence was accepted as correct.

Proust was born in Angers, France. When in his 30's, he moved to Spain. There, he taught chemistry in several universities. He developed ways of obtaining sugar from grapes and did other research on foods.

**Proust, Marcel** (1871-1922), was a French author. His seven-part novel *À la recherche du temps perdu (Remembrance of Things Past),* is a masterpiece. It consists of *Swann's Way, Within a Budding Grove, The Guermantes Way, Cities of the Plain, The Captive, The Sweet Cheat Gone,* and *The Past Recaptured.*

*Remembrance of Things Past* is filled with vivid characters and provides a panorama of French high society in the process of change. It is a study of love, jealousy, marriage, and the evils of the age and describes the growth of the narrator, Marcel, into a mature artist. Marcel, except in one episode, is both participant and observer. He tells his story with frankness, intelligence, sensitivity, irony, and humour. The work has brilliant dialogue and offers original and profound observations about music, art, writing, theatre, and criticism. Proust compared the novel's structure to that of a cathedral, whose diverse parts form a whole, or that of a musical composition in which themes are introduced, abandoned, and resumed.

To Marcel, reality remains elusive. It is constantly changing, because the passing of time alters not only his own perspective, but also the nature of what is perceived. He finally recognizes that reality is not external but something stored in the depths of man's unconscious memory. There it is preserved from the changes of time, but is accessible only in rare and happy moments. Artists can reveal reality to mankind because their sensitivity enables them to dig deeply into their own unconscious memory.

Proust began writing *Remembrance of Things Past* in 1908, but he could not find a publisher. He finally published *Swann's Way* in 1913 at his own expense. Most of the public greeted it with indifference or hostility, but discriminating readers admired it. Both the author's poor health and World War I delayed the publication of later volumes until 1918. Proust continually revised the novel, and the last three parts were not published until after his death.

Proust was born in Paris. During the 1890's, he wrote stories and magazine articles that were noted for their elegant but artificial style. His unfinished novel, *Jean Santeuil* (1895-1899, published 1952), has characters and incidents that foreshadow his major novel. *Contre Sainte-Beuve* (1908-1910, published 1954) is a collection of critical essays and Proust's studies on poet Charles Baudelaire and novelist Gustave Flaubert. They reveal Proust as a highly sensitive critic with theories on the arts that were far in advance of his time.

See also **French literature** (The four masters).

**Provençal.** See **French language** (Old French); **Troubadour; Mistral, Frédéric.**

**Proverb** is a brief saying that presents a truth or some bit of useful wisdom. It is usually based on common sense or practical experience. The effect of a proverb is to make the wisdom it tells seem to be self-evident. The same proverb often occurs among several different peoples. True proverbs are sayings that have been passed from generation to generation primarily by word of mouth. They may also have been put into written form. The most notable collection of such sayings is the Book of Proverbs in the Hebrew Bible, or Old Testament. The book contains some of our most common proverbs. Some of them are:

> Hope deferred maketh the heart sick.
> A good name is rather to be chosen than great riches.
> A soft answer turneth away wrath.
> Pride goeth before destruction, and
> a haughty spirit before a fall.

Proverbs often find their way into literature. Many of the lower-class characters in *The Canterbury Tales* (late 1300's) by Geoffrey Chaucer refer to proverbs. Miguel de Cervantes' novel *Don Quixote* (1605, 1615) contains many proverbs. Cervantes collected the proverbs from the Spanish peasants, who supposedly could carry on a sensible conversation for a whole evening in nothing but proverbs (see **Don Quixote**).

Benjamin Franklin used many proverbial expressions in his *Poor Richard's Almanac,* issued every year from 1733 to 1758. Franklin wrote many of them himself, and took the rest from other sources. Many are still quoted (see **Poor Richard's Almanac**).

See also **Epigram.**

**Proverbs, Book of,** is a book of the Hebrew Bible, or Old Testament. It is also known as the *Proverbs of Solomon* because, according to tradition, King Solomon wrote it. However, scholars believe that the book's assortment of moral and religious sayings, poems, and warnings come from various periods in the history of

ancient Israel. They were probably not collected in their present form until after the period of the Babylonian Exile, which ended in 539 B.C.

The Book of Proverbs is a product of the educational system of ancient Israel. Children were educated primarily at home. The instructional value of many sections of Proverbs reflects the teachings of parents trying to raise their children to become successful and responsible adults. Other sections may come from a palace school for the training of government officials. The book has earned universal appeal because it contains material valuable to all people who hope to live a life of wisdom, honesty, responsibility, self-control, and respect for God. Many of the book's sayings have become part of everyday speech.

See also **Proverb; Bible** (The Old Testament).

**Province,** in Roman times, was a conquered district ruled by an official from Rome. Later, independent countries that united to form a state frequently called themselves provinces. An example is the United Provinces of Holland. Still later, independent countries were divided into regions called provinces.

In early Irish history, Ireland consisted of five provinces, each of which generally had its own king. Eventually, the five provinces evolved into four provinces called Connacht, Leinster, Munster, and Ulster. Ireland's provinces no longer have any political or administrative meaning, but they are still important for some cultural reasons. For example, Gaelic sports are organized on the basis of the Irish provinces. See **Ireland, History of.**

Canada comprises 10 provinces, each with its own local government. Canadian provinces perform much the same functions as Australian or American states.

**Provisional government** is a temporary government frequently set up during or after a revolution or other disorder. Provisional governments are usually established because of a breakdown or rejection of the previous constitutional system. They are intended to facilitate the establishment of another constitutional government.

**Proxy** is a substitute. Suppose you have been assigned to deliver an important report before a meeting of your club. On the day of the meeting you are too ill to attend. You therefore call upon another club member to act for you. This club member becomes your *proxy* and delivers your report to the club meeting.

The use of a proxy is limited almost entirely to business meetings. A shareholder in a company who is unable to attend a company meeting may request another shareholder to act as a substitute and vote on any issue. This must be a formal request. The person who casts the vote is known as a proxy. The paper that authorizes the substitute to vote is also called a proxy.

In political elections, voting by proxy is forbidden. But at political conventions, many delegates vote by proxy. In law and the social sciences, an easily measured trait is sometimes said to be a proxy for a trait that is more difficult to measure. For example, in laws that prohibit the drinking of alcohol by minors, a person's age is a proxy for maturity.

**Prune** is a sweet plum that has been dried. The drying gives prunes their wrinkled appearance. Plums that are especially well suited to drying are called *prune plums.* The prune has a high iron and vitamin content.

Prune plums were first grown in western Asia, near the Caucasus Mountains and the Caspian Sea. Today they are a leading crop in California, where about 145,000 metric tons of prunes are produced yearly. The warm, dry climate of the fertile valleys provides ideal growing conditions. Prunes are also grown in central Europe, and South America.

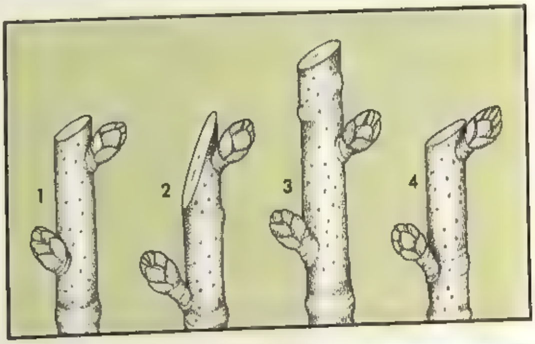
The French prune plum (Prune d'Agen) is the commonest kind used to make prunes. Other extremely sweet varieties of European plums, including French, Italian, and Sugar, can also be used. Other prune plums include the Imperial, and the Robe de Sergeant.

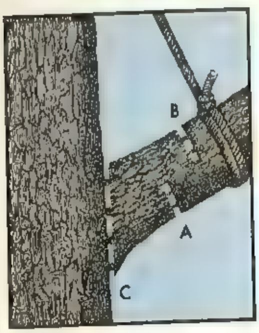
Prune plum trees usually produce a crop five to seven years after planting. The trees produce white blossoms in spring. The fruit develops in summer. In August or September, the fully developed fruit falls to the ground or is machine harvested. It is then taken to a dehydrator in lug boxes or portable bins, where it is placed for a few seconds in a hot lye solution. The dehydrator dries the plums with a forced draught of hot air. The drying lasts from 14 to 24 hours. This drying process reduces 3 pounds of fresh plums to about one pound of prunes.

The prunes are placed in bins, where they are *cured* for at least two weeks. Curing gives the prunes a uniform moisture content of between 18 and 20 per cent. The prunes are then graded according to size, and may be stoned. Before the prunes are packed to be sold, they are given a hot water or steam bath to pasteurize them and to bring their moisture content to between 26 and 32 per cent.

See also **Plum.**

**Pruning** is the cutting away of plant parts, such as branches, shoots, buds, or roots. Pruning helps plants recover from the shock of being moved. It controls the shape and beauty of ornamental plants. Pruning also helps improve the quantity and quality of fruit.




**Principles of pruning.** Figure 1 in the illustrations above shows a correctly pruned branch. The angled cut is just above the bud. In figure 2, the angle of the cut is too sharp. The cut in figure 3 is too high above the bud, and in figure 4 it is too close to the bud. The correct method of removing a tree limb is shown on the right. The limb is cut halfway through at A and then at B before it is cut close to the trunk at C.

**Pruning** often involves removing certain top branches so that lower ones can receive more sunlight. These photographs show, *left to right,* an apple tree before and after pruning. The wooden boards placed in the pruned tree force the branches to grow in the desired directions.

Transplanted trees and shrubs are pruned to prevent water loss through the leaves. Usually, about a third of the leaf-producing area is removed. Whole branches or the top third of each branch may be removed.

However, the top of a shade tree should not be pruned, because such pruning would destroy the shape of the tree. Spruce, pine, and similar evergreens usually are not cut. They develop naturally into their characteristic shapes.

Gardeners remove weak stems from shrubs at ground level. The diseased and broken branches are also removed. People prune shrubs that flower early in the spring, such as lilacs, just after they flower. Shrubs that flower in the summer, like hybrid tea roses, are pruned in the spring. Gardeners shear hedges to encourage dense and compact growth and to keep the hedges in a desired shape.

Fruit growers keep their fruit trees well pruned. By cutting out undesirable parts, they obtain low trees with open tops. Such pruning allows light to reach all parts of the tree. It also makes spraying the trees and picking the ripe fruit easier. Well-pruned trees produce high-quality fruit. Trees pruned so that the limbs are well spaced are less likely to break when the fruit loads down their branches.

Training of a fruit tree begins when the tree is transplanted in the field from the nursery. At that time, the grower prunes the tree to a height of about 90 centimetres. This pruning stimulates the development of branches. The next year, the grower selects the strongest and best branches to remain on the tree and cuts the others off. During their early years, fruit trees require only a little pruning. Old trees are usually pruned heavily to increase their vigour and their production.

See also **Fruit**.

**Prussia** was a powerful military nation in north-central Europe, for hundreds of years. When the Prussian king became emperor of a united Germany, in 1871, Prussia became the largest state in the German Empire. After World War II (1939-1945), Prussia was broken up into small districts and ceased to exist as a German state. Much of the land once called Prussia now lies in eastern Germany, Lithuania, Poland, and Russia.

Prussia was more than the name of a country, however. It also represented a military way of life. Prussian armies were among the most rigidly drilled and disciplined in the world. The generals, from the aristocratic class called *Junkers,* owned huge estates.

**The land and its resources.** At the height of its power in the late 1800's, Prussia occupied the northern two thirds of Germany. It extended from Belgium and the Netherlands on the west to Russia on the east. The North Sea and the Baltic Sea bordered Prussia on the north. Austria-Hungary lay to the south.

Prussia had a low, sandy coast, bordered by many lagoons. The coast was separated from the central plain of Prussia by a belt of lakes and tree-covered hills. The central plain contained many lakes and waterways. Highlands to the south of the central plain contained deposits of many minerals, including coal, iron, silver, copper, nickel, and lead. The most fertile land for farming lay in the valleys of the Oder, Elbe, and Rhine rivers.

**The people and their work.** The rulers of Prussia, headed by the royal family of Hohenzollern, controlled lands originally peopled by Slavs, and conquered and colonized by Germans in the Middle Ages. There were about 200 families of hereditary aristocrats, or Junkers, who owned most of the land. People who worked the farms had no land of their own. Men served in the Prussian army about eight or nine months each year.

The main cities of Prussia were Berlin, which was the capital, and Königsberg (now Kaliningrad) in East Prussia.

**Early history.** The story of the rise of the Hohenzollern family is the story of Prussia. The Hohenzollerns were a family of German counts. In 1415, the Hohenzollerns became rulers, or *margraves,* of the large district, or *mark,* of Brandenburg. When they came to take part in the election of the Holy Roman Emperor, they received the title of *Elector of Brandenburg.* In the 1600's,


**Prussia** became the greatest military power in Europe during the 1800's. It began as the German district of Brandenburg and grew into the Kingdom of Prussia in 1701. Prussia reached its peak in 1871, when it became the largest state in the newly formed German Empire.

the Hohenzollerns added the districts of East Prussia and Pomerania to their territory.

Prussia was greatly strengthened during the rule of the Great Elector, Frederick William, from 1640 to 1688. His son, Frederick I, was crowned the first King of Prussia in 1701. He built a strong army.

**Frederick the Great,** or **Frederick II,** came to the throne of Prussia in 1740. He helped form the Prussian theory of government based on discipline and authority. Frederick believed in the idea "might makes right." Frederick's tax collectors were called *war commissars,* and all the members of his cabinet were called *war ministers.* Using the strong army his father had organized, he seized Silesia from Austria in 1740. In the late 1700's, he partitioned Poland with Russia and Austria.

**Napoleonic period.** Less skilful rulers followed Frederick the Great, and Napoleon easily defeated the Prussians in 1806. To restore Prussia's power, Gerhard von Scharnhorst and August von Gneisenau set up universal military training. The schools were designed to make the people better soldiers. As a result, more people learned to read and write in Prussia than in any other country of Europe in the 1800's. A new Prussian army under the command of Gebhard von Blücher helped to defeat Napoleon at Leipzig in 1813 and at Waterloo in 1815.

**German empire.** Prussia reached the peak of its power after King Wilhelm I came to the throne in 1861 and chose Otto von Bismarck as prime minister. Bismarck greatly strengthened the Prussian army, and set out to unify Germany. In 1864, Prussia and Austria gained the Danish provinces of Schleswig and Holstein. When Austria quarrelled with Prussia, Bismarck formed the North German Confederation, including the states north of the Main River. King Wilhelm headed the confederation. Bismarck next manoeuvred France into war in 1870, and took almost all of Alsace and part of Lorraine as the price of peace. This victory enabled him to persuade the southern states of Germany to join the confederation. In 1871, the North German Confederation became the German Empire. Wilhelm then became the first emperor of the new German Empire.

**Decline of Prussia.** The Prussian desire for more land was one cause of World War I (1914-1918), but Germany lost. In the peace settlement, a large strip of land was given to Poland. This strip, called *the Polish Corridor,* separated West Prussia from East Prussia. In the new German republic, Prussia and the other states became administrative districts. Hitler started World War II in Europe by invading Poland to take back the land lost in World War I. The war brought heavy destruction to most of Prussia. At the end of the war, the Soviet Union seized the northern half of East Prussia. Poland took the rest of Prussia east of the Oder and Neisse rivers, along with the city of Stettin (now Szczecin) west of the Oder. The district of Brandenburg was similarly divided along these rivers, and the section west of the rivers was placed in the Soviet zone of occupation, which later became East Germany.

In 1947, the state of Prussia was legally abolished by the Allied Control Council. In 1952, Communist East Germany also abolished the state of Brandenburg, dividing it into administrative districts. These districts were rejoined into the state of Brandenburg in 1990 when Germany was reunified.

**Related articles** in *World Book* include:

Berlin
Bismarck, Otto von
Blücher, Gebhard von
Brandenburg
Franco-Prussian War
Frederick II (of Prussia)
Frederick III (of Prussia)
Frederick William (of Brandenburg)
Frederick William I (of Prussia)
Germany
Hindenburg, Paul von
Hohenzollern
Junkers
Louise of Mecklenburg-Strelitz
Polish Corridor
Seven Years' War
Succession wars
Wilhelm
World War I
World War II

**Prussian blue** is a dark blue solid substance with a coppery lustre. It was formerly used in the manufacture of laundry bluing, paint, and blue ink. Aniline products, however, are replacing Prussian blue for these pur-

poses (see **Aniline**). The chemical is prepared commercially by mixing ferrous sulphate and sodium ferrocyanide, and then adding sodium chlorate.

Prussian blue does not crystallize or dissolve in water. But alkalis will decompose it (see **Alkali**). Its chemical formula is $Fe_4[Fe(CN)_6]_3$. A colour used in oil painting is also called Prussian blue.

See also **Prussic acid**.

**Prussic acid,** also known as *hydrocyanic acid,* is called *prussic acid* because it was first obtained from Prussian blue (see **Prussian blue**). The pure acid is a clear liquid. It has a low boiling point and evaporates quickly at room temperature. The acid has a faint odour of bitter almonds. It interferes with the body's ability to use oxygen and is one of the most poisonous substances known. Hydrocyanic acid gas has been used to execute condemned criminals. The gas is created when lumps of sodium or potassium cyanide are dropped into sulphuric acid. Hydrocyanic acid is also used to control the scale insect on orange trees. The acid's chemical formula is HCN.

**Prut** is an important river in south-central Europe. It rises in the Carpathian Mountains in southwestern Ukraine, and flows southeast to form part of the Moldova-Romanian border. For location, see **Romania** (physical map). It meets the Danube River north of the city of Reni, in Ukraine. The Prut is more than 800 kilometres long, but is navigable only for about 110 kilometres, south of Leovo, in Romania.

**Przewalski's horse,** also called *Przhevalski's horse,* is a species of horse which once roamed central Asia in herds. The Russian explorer Nikolai Przewalski found the skin and skull of one of these wild horses in 1881. About 20 years later, animal collectors captured 32 young horses. Przewalski's horse is now extinct in the wild, but more than 1,200 live in zoos.

Przewalski's horse is related to the domestic horse, but it resembles a donkey. It has a greyish-brown coat, a brown mane, and a black streak along its back. There are faint bars on its upper legs, and its lower legs are black. Przewalski's horse stands about 135 centimetres tall at its shoulders.

**Przewalski's horse** is related to the domestic horse, but resembles a donkey. It is extinct in the wild.

**Scientific classification.** Przewalski's horse belongs to the family Equidae. It is *Equus przewalskii.*

See also **Horse** (Wild horses; picture); **Tarpan.**

**Psaila, Carmelo (Dun Karm)** (1871-1961), a Maltese priest, came to be regarded as Malta's national poet. His works include his country's national anthem, *Innu Malti* (Maltese Anthem). Dun Karm was a founder member of the Maltese Academy, which formulated a grammar of the Maltese language and published Maltese literature. In 1934, he and other Maltese writers persuaded the British rulers of the colony of Malta to recognize the Maltese language. Dun Karm did most of the work on *English-Maltese Dictionary* (1937-1955).

**Psalms, Book of,** is a collection of 150 poems or songs in the Old Testament, or Hebrew Bible. The book is sometimes called the Psalter. The Psalms were probably part of the religious ceremonies of the ancient Israelites. Even today, the Psalms are used in both Jewish and Christian worship services.

Much of the Old Testament consists of the history of Israel or God's commands to His people. The Psalms are a special part of the Old Testament because they tell about people's personal responses to God. The Psalms reveal the individual's feelings when faced with both the joys and the sorrows of everyday life. The Psalms contain hymns praising and thanking God and prayers to God in times of trouble. Perhaps the best known Psalm is number 23, which begins, "The Lord is my shepherd; I shall not want."

The Book of Psalms is associated with the Israelite leader King David. According to tradition, David wrote 73 of the Psalms. However, many modern scholars doubt that he wrote all of them. Other musicians may have written the Psalms to honour him. King David was a famous musician, and the Psalms were probably an important part of the musical life of ancient Israel.

Many of the Psalms were probably written in King David's time, about 1000 B.C. Some of the Psalms may have been based on ancient Near Eastern songs and thus could be even older. Many Biblical prophets were influenced by the Psalms. Therefore, much of the book had probably been established by the age of prophecy in ancient Israel, which began in the 700's B.C. Some Psalms may reflect historical events that took place as late as the 500's B.C.

**Pseudonym** is a fictitious name taken by authors and other people who wish to conceal their true identities or simply to be known by another name. One famous author's pseudonym is Mark Twain, the name adopted by the American humorist Samuel Langhorne Clemens. The "stage names" assumed by actors and actresses are also kinds of pseudonyms.

See also **Name** (Other names).

**Pseudoscience.** See Alchemy; Astrology; Fortune-telling; Graphology; Numerology; Palmistry; Phrenology.

**Psi particle,** also called a *J particle,* is a type of subatomic particle. A psi particle consists of a *quark* and an *antiquark.* A quark is an elementary particle that combines with other quarks to form such familiar particles as protons and neutrons. An antiquark has the same properties as a quark but carries an opposite electric charge. In a psi particle, the quark is a *charmed quark,* and the antiquark is an *anticharmed quark.* See **Quark.**

The structure of a psi particle is similar to that of a hydrogen atom. Both a hydrogen atom and a psi particle consist of two particles bound together. However, the components of a hydrogen atom—a proton and an electron—are bound together by electromagnetism. The quark and antiquark of a psi particle, on the other hand, are held together by the *strong nuclear force,* also called the strong interaction (see **Force** [Fundamental forces]). Just like a hydrogen atom, a psi particle carries no electric charge.

The psi particle was discovered in 1974 by two groups of American physicists working independently at the Stanford Linear Accelerator Center in California, and Brookhaven National Laboratory on Long Island, New York. The discovery of the psi particle and the study of its properties provided strong evidence for the existence of the quark.

**Psittacosis** is a contagious disease that is carried by some birds. It is also called *parrot fever* or *ornithosis.* Psittacosis occurs mostly in members of the parrot family, but is also found in pigeons and some poultry. Human beings can contract this disease by handling sick birds or contaminated articles.

Psittacosis is caused by a virus-like organism *chlamydia.* Symptoms include nausea, diarrhoea, chills, and high fever. Antibiotics will cure some cases, but serious infections can cause pneumonia or death. Because of this disease, some countries forbid the importation of parrots without rigid inspection.

**Psoriasis** is a skin disease characterized by thick, raised, red patches covered with silvery-white scales. In most people, these patches are the only symptom of the disease. But the patches may burn, crack, and bleed, especially if the skin is irritated by scratching. The patches usually appear on the elbows and knees. But in severe cases, they may cover the body. A form of arthritis is associated with many cases of psoriasis, though the skin patches themselves do not cause the arthritis.

No one knows what causes psoriasis. However, medical researchers believe an attack of the disease results when cells in the outer layer of the skin divide more rapidly than normal. These cells do not mature completely and the skin becomes abnormally thick. In addition, the number and size of blood vessels in the lower layer of the skin increase abnormally.

Psoriasis can be inherited, but it is not contagious. An attack may be influenced by an emotional condition, such as tension. In others, it may be affected by such environmental factors as sunlight and cold weather.

There is no cure for psoriasis, but sufferers may get temporary relief with coal tars, used alone or with sunlight or an ultraviolet lamp. They may also use various cortisone ointments. In extremely severe cases, including those that involve severe and disabling arthritis, special drugs may be taken to stop the progression of the disease.

**Psyche** was a princess in ancient mythology. She was so beautiful that people turned to worshipping her instead of Venus, goddess of love. Venus became angry and sent her son Cupid (Love) to punish her. However, Cupid fell in love with Psyche and carried her off to his fairyland palace of gold and gems. Cupid visited Psyche only at night and told her that, if she ever saw him in the light, he must leave her forever. But Psyche, urged by her wicked sisters, one night lighted a lamp to see Cupid as he slept. He awoke and left her.

In her grief, Psyche searched for Cupid, finally arriving at the palace where Venus was living. The goddess made Psyche her slave and gave her four nearly impossible tasks. Psyche performed the first three, but in the fourth, a visit to the queen of the underworld, Psyche failed and became trapped in the underworld. Cupid, however, rescued her. With the help of Jupiter, king of the gods, Cupid won Venus' forgiveness and made Psyche a goddess and his wife. See **Cupid.**

The story of Cupid and Psyche has been interpreted symbolically. According to this interpretation, Psyche (which means *soul* in Greek) represents the human soul's encounter with love and passion (Cupid) and its struggle to achieve immortality.

**Psychedelics.** See **Hallucinogenic drug.**

**Psychiatry** is the branch of medicine concerned with the diagnosis and treatment of mental illness. A psychiatrist is a doctor who, after qualifying in medicine completes several more years of training in the treatment of mentally ill patients.

Many techniques are used in treating mentally ill patients. A psychiatrist might discuss problems with one patient; prescribe drugs for another; and combine discussions, drugs, and other therapy for a third.

Some psychiatric therapy takes place in a psychiatrist's office or in a clinic. But severe cases require hospital care. Many hospitals and clinics employ psychiatric nurses, psychiatric social workers, and clinical psychologists. These specialists have had special training to help patients solve their problems.

### Psychiatric disorders

Mental disorders are characterized by a variety of symptoms, such as abnormal moods or behaviour, excessive anxiety, and hallucinations. These symptoms often upset the person who experiences them and may interfere with the person's ability to lead a normal life. The causes of most mental disorders are unknown. Some may arise from emotional conflicts or psychological stress. Others may result from learned behaviour patterns. Still others are caused by biological defects in the brain. Many mental disorders are believed to result from a combination of emotional, social, and biological factors.

Ways of defining and classifying mental disorders have changed over time. Older classification systems made a distinction between *psychoses* and *neuroses.* Psychoses are severe mental disorders in which a person loses touch with reality and experiences such symptoms as delusions and hallucinations (see **Psychosis**). Neuroses are milder disorders marked by excessive anxiety (see **Neurosis**). Other classes of mental disorders include *organic disorders* and *personality disorders.* Organic disorders are abnormalities in personality or behaviour caused by brain injury or brain deterioration. Personality disorders involve a tendency to act in socially unacceptable or self-defeating ways.

### Treatment

Psychiatrists use a number of treatments for mental disorders. The two main types of treatments are (1) somatic therapy and (2) psychotherapy.

**Somatic therapy** usually involves the use of medications. One commonly used group of medications is *neuroleptic* drugs, sometimes called *antipsychotics.* These drugs are used mainly to treat psychosis. *Antidepressants* are a group of drugs used to control gloominess. *Anxiolytics* reduce anxiety and are used chiefly to treat neurosis. *Lithium carbonate* is a drug used to treat *bipolar disorder,* also called *manic-depressive disorder.* A person with this disorder experiences alternating periods of sadness and joy.

A type of somatic therapy called *electroconvulsive therapy* (ECT) is sometimes used to treat long-standing mental illness, including severe depression. In this type of therapy, a mild electric current is passed through the patient's brain after the patient has been *anaesthetized* (given a drug that causes sleep) (see **Mental illness** [Electroconvulsive therapy]).

**Psychotherapy** is any form of treatment by psychological means. There are many types of psychotherapy. Most psychotherapy is based on discussions between the patient and the psychiatrist. The doctor works to build the patient's confidence and to help the patient develop a more contented outlook toward life. Commonly, the patient and doctor meet for a psychotherapy session once or twice a week for several months. But sessions may occur more frequently or less frequently.

Sometimes groups of three or more patients participate in *group therapy.* By meeting as a group with the psychiatrist, the patients help each other understand themselves. The doctor may encourage the patients to act out their problems in *psychodramas.*

When working with a child, the psychiatrist may use *play therapy.* The child, instead of talking about his or her problems, acts them out with toys and games.

Two widely used forms of psychotherapy are *psychoanalysis* and *behaviour therapy.* Psychoanalysis focuses on unconscious thoughts and feelings. According to psychoanalytical theory, the causes of many mental illnesses lie buried in the unconscious. The patient visits the psychiatrist and talks about whatever comes to mind. The doctor helps the patient understand his or her problems by uncovering the causes. The patient may continue psychoanalytical treatment for a number of years. See **Psychoanalysis.**

Behaviour therapy uses rewards and punishments to encourage patients to act in a healthier way. The goal of behaviour therapy is to try to help patients change their behaviour rather than to help them understand why they act the way they do. The psychiatrist may praise or reward the patient for "good" behaviour. This technique, called *positive reinforcement,* is considered to be more effective than *negative reinforcement,* such as scolding the patient for "bad" behaviour.

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Freud, Anna
Freud, Sigmund
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Menninger (family)
Mental illness
Neurosis
Psychoanalysis
Psychology
Psychosis
Psychosomatic medicine
Psychotherapy

**Psychical research** is the original name of a field of study that is now known as *parapsychology.* It involves the investigation and study of so-called *psychical* (mental) phenomena that are outside the field of normal psychology and the ordinary laws of behaviour. Historically, psychical research focused on *spiritualism* (communication with the dead), the existence of ghosts, and fortune-telling. Modern interest is directed at *extrasensory perception* (ESP) and related phenomena. ESP is an awareness of something, such as another person's thoughts, without the use of the senses of hearing, sight, smell, taste, or touch.

Throughout history, there have been many reports and claims of psychical phenomena. Some can be neither verified nor disproved. Psychical research can provide a basis for an assumption that psychical phenomena exist, or it can expose false or fraudulent claims. But most scientists believe that the existence of such phenomena has not been proven.

See also **Extrasensory perception; Clairvoyance; Parapsychology; Spiritualism; Telepathy.**

**Psychoanalysis** is a method of treating mental illness founded by the Austrian doctor Sigmund Freud. Freud developed this treatment during the late 1800's and early 1900's. Other psychiatrists developed variations of his technique. The term *psychoanalysis* also refers to the theories on which such treatment is based.

According to Freud, mental disorders could be cured only by uncovering a patient's unconscious wishes and fears. He believed that all behaviour is influenced by instincts, fears, and unconscious mental processes not controlled by rational thought. He claimed that early childhood bodily experiences, especially sexual ones, shape an individual's behaviour in later life.

Psychoanalysts believe that unpleasant experiences, especially during childhood, may become buried in the unconscious mind and cause mental illness. Psychoanalytical treatment tries to bring these experiences out of a patient's unconscious mind and into the conscious mind.

**Psychoanalytical treatment** generally lasts for two to five years with sessions three to five times a week. The patient relaxes on a couch while the psychoanalyst sits out of view. The patient is instructed to reveal all thoughts as they occur. This is called *free association.* The patient and the analyst attempt to understand the psychological meaning of the ideas, fantasies, dreams, and feelings that are expressed. During the course of the treatment, patients often transfer strong feelings they have for other people to the therapist. This process is called *transference.* Transference reveals certain attitudes acquired by patients in early life that have continued to interfere with their relationships with other people. By interpreting this transference, the therapist attempts to help patients achieve greater maturity and freedom in their relationships.

**Psychoanalytical theory.** Freud taught that people do not say or do anything accidentally. Unconscious mental activity causes such "accidents" as slips of the tongue—for example, calling a person by the wrong name without realizing it—or forgetting an appointment. According to Freud, the mind experiences more unconscious than conscious activity.

Freud divided the mind into three parts: (1) the *id,* (2) the *ego,* and (3) the *superego.* Babies are born with an id, a group of instincts within the unconscious. As children grow, they develop an ego and a superego. The

ego governs such areas as memory, voluntary movement, and decision making. The superego enables the mind to tell right from wrong. Severe conflicts between two of the parts may cause emotional problems. Difficulties might arise, for example, if the id produces strong desires to do things, but the superego insists that such desires are wrong.

Freud believed that children grow through a series of five overlapping stages of what he called *psychosexual development.* These stages are (1) the *oral phase,* (2) the *anal phase,* (3) the *phallic stage,* (4) *latency,* and (5) *adolescence.* During the oral phase, infants find pleasure in sucking. During the anal phase, which lasts to about age 4, children enjoy controlling the discharge of body wastes. Then, in the phallic stage, they become increasingly aware of their sex organs. They also develop an *Oedipus complex,* a strong attraction to the parent of the opposite sex (see **Oedipus complex**). While in primary school, children move into the less emotional latency period. The fifth stage, adolescence, involves a struggle between childish feelings of dependency and adult longings for independence.

Emotional problems during any of the five stages, according to Freud, can cause characteristics of that stage to last into adulthood. A disturbed boy, for example, might remain unconsciously in love with his mother and jealous of his father even as an adult.

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| Jones, Ernest | Psychotherapy |
| Jung, Carl G. | |

**Psychological warfare** uses propaganda to reach certain goals. It can be used before a war to deter fighting, or during a war to win it. A nation uses psychological warfare to convince its potential enemies that they cannot possibly win, and that they should not start to fight. During a war, it uses psychological warfare to convince enemy troops that their cause is unjust and hopeless, and to weaken their trust in their leaders. Its goal is to destroy the enemy's will to fight.

See also **Propaganda; World War II** (The secret war).

**Psychology** is the scientific study of mental processes and behaviour. Psychologists observe and record how people and other animals relate to one another and to the environment. They look for patterns that will help them understand and predict behaviour, and they use scientific methods to test their ideas. Through such studies, psychologists have learned much that can help people fulfil their potential as human beings and increase understanding between individuals, groups, nations, and cultures.

Psychology is a broad field that explores a variety of questions about thoughts, feelings, and actions. Psychologists ask such qustions as: "How do we see, hear, smell, taste, and feel? What enables us to learn, think, and remember, and why do we forget? What activities distinguish human beings from other animals? What abilities are we born with, and which must we learn? How much does the mind affect the body, and how does the body affect the mind? For example, can we change our heart rate or temperature just by thinking about doing so? What can our dreams tell us about our needs, wishes, and desires? Why do we like the people we like? Why are some people bashful and others not shy at all? What causes violence? What is mental illness, and how can it be cured?"

The research findings of psychologists have greatly increased our understanding of why people behave as they do. For example, psychologists have discovered much about how personality develops and how to promote healthy development. They have some knowledge of how to help people change bad habits and how to help students learn. They understand some of the conditions that can make workers more productive. A great deal remains to be discovered. Nevertheless, insights provided by psychology can help people function better as individuals, friends, family members, and workers.

### Psychology and other sciences

Psychology is closely related to the natural science of biology. Like many biologists, psychologists study the abilities, needs, and activities of human beings and other animals. But psychologists focus on the workings of the nervous system, especially the brain.

Psychology is also related to the social sciences of anthropology and sociology, which deal with people in so-

**Animal behaviour,** as well as human behaviour, is studied in the field of psychology. This psychologist has taught sign language to a gorilla named Koko. In the photo, Koko is making the sign for "Smokey," the name of the kitten held by the psychologist.

ciety. Like anthropologists and sociologists, psychologists investigate the attitudes and relationships of human beings in social settings. These three academic disciplines often study the same kinds of problems from different perspectives. However, psychologists concentrate on individual behaviour. They are especially interested in the beliefs and feelings that influence a person's actions.

In addition, psychology is similar to a medical field called *psychiatry.* Most psychologists have a degree in psychology and may or may not specialize in the treatment of mental disorders. Psychiatrists, on the other hand, usually have a medical degree and devote themselves to treating mental disorders.

### Methods of psychological research

In their research, psychologists use much the same approach as other scientists do. They develop theories, also called *hypotheses,* which are possible explanations for what they have observed. They then use scientific methods to test their hypotheses. The chief techniques used in psychological research include (1) naturalistic observation, (2) systematic assessment, and (3) experimentation.

**Naturalistic observation** involves watching the behaviour of human beings and other animals in their natural environment. For example, a researcher might study the activities of chimpanzees in the wild. The psychologist looks for cause-and-effect relationships between events and for broad patterns of behaviour.

Psychologists conducting such studies try to observe a group large enough and typical enough to accurately reflect the total population. Such a group is called a *representative sample.* Observers also attempt to keep their personal views from influencing the study. In addition, psychologists try to prevent their presence from affecting the behaviour being observed. A careful scientist hides from sight or remains on the scene long enough to become a familiar part of the environment.

Naturalistic observation is a valuable source of information to psychologists. The research itself has less effect on the subjects' behaviour than a controlled experiment does. But observation alone seldom proves a cause-and-effect relationship between two or more events. As a result, psychologists use naturalistic observation chiefly as an exploratory technique to gain insights and ideas for later testing.

**Systematic assessment** is the general name for a variety of organized (systematic) methods used to examine (assess) people's thoughts, feelings, and personality traits. The chief types of systematic assessment include case histories, surveys, and standardized tests.

A *case history* is a collection of detailed information about an individual's past and present life. Nearly all clinical psychologists gather case histories of their patients to help them understand and treat the patients' problems. A psychologist who notices similar experiences or patterns of thought in several case histories may gain insight into the causes of certain emotional disorders.

A *survey,* also called a *public opinion poll,* is a study that measures people's attitudes and activities by asking the people themselves. Surveys provide information on political views, consumer buying habits, and many other topics. A psychologist conducting a survey prepares carefully worded questions. The researcher may inter-

### Major fields of psychology

**Abnormal psychology** deals with behaviour disorders and disturbed individuals. For example, researchers might investigate the causes of violent or self-destructive behaviour or the effectiveness of procedures used in treating an emotional disturbance.

**Clinical psychology** uses the understandings derived from developmental and abnormal psychology to diagnose and treat mental disorders and adjustment problems. Some clinical psychologists work to develop programmes for the prevention of emotional illness or conduct basic research on how individuals can better cope with the problems of daily life.

**Comparative psychology** explores the differences and similarities in the behaviour of animals of different species. Psychologists in this field make systematic studies of the abilities, needs, and activities of various animal species as compared with human beings.

**Developmental psychology** studies the emotional, intellectual, and social changes that occur across the life span of human beings. Many developmental psychologists specialize in the study of children or adolescents.

**Educational psychology** attempts to improve teaching methods and materials, to solve learning problems, and to measure learning ability and educational progress. Researchers in this field may devise achievement tests, develop and evaluate teaching methods, or investigate how children learn at different ages.

**Industrial psychology** is concerned with people at work. Industrial psychologists investigate such matters as how to make jobs more rewarding or how to improve workers' performance. They also study personnel selection, leadership, and management. Organizational psychology is a closely related field.

**Learning,** as a field of psychology, examines how lasting changes in behaviour are caused by experience, practice, or training. The psychologists who study learning are interested in the importance of rewards and punishment in the learning process. They also explore how different individuals and species learn, and the factors that influence memory.

**Motivation,** as a field of psychology, is the study of what conscious and unconscious forces cause human beings and other animals to behave as they do. Motivational psychologists focus on bodily needs, sexual drives, aggression, and emotion.

**Perception,** in psychology, is the study of how an organism becomes aware of objects, events, and relationships in the outside world through its senses. Psychologists in the field of perception analyse such topics as vision, hearing, taste, smell, touch, and movement.

**Personality** refers to the characteristics that make individuals different from one another and account for the way they behave. Personality psychologists investigate how an individual's personality develops, the chief personality types, and the measurement of personality traits.

**Physiological psychology** examines the relationship between behaviour and body structures or functions, particularly the workings of the nervous system. Physiological psychologists explore the functions of the brain, how hormones affect behaviour, and the physical processes involved in learning and emotions.

**Social psychology** studies the social behaviour of individuals and groups, with special emphasis on how behaviour is affected by the presence or influence of other people. Social psychologists concentrate on such processes as communication, political behaviour, and the formation of attitudes.

view participants personally or post questionnaires to them. If the psychologist wishes to form general conclusions, the survey must collect responses from a representative sample of individuals.

A *standardized test* is an examination for which average levels of peformance have been established and which has shown consistent results. In addition, uniform methods of administering and scoring the test must have been developed. Psychologists use standardized tests to help measure abilities, aptitudes, interests, and personality traits.

Still other tests, called *projective tests,* yield clues to a person's inner feelings. In a Rorschach test, for example, the subject describes what he or she sees in a series of inkblots. In the Thematic Apperception Test, the subject invents a story about the characters in each of a series of pictures. Psychologists can interpret responses on these tests as expressions of an individual's personality.

Case histories, surveys, and standardized tests enable psychologists to gather much information that they could not detect by naturalistic observation. However, the accuracy of the information gathered depends on well-designed studies and on truthful, complete responses from the individuals who participate.

**Experimentation** helps a psychologist discover or confirm cause-and-effect relationships in behaviour. In a typical experiment, the researcher divides subjects at random into two groups. One group is called the *experimental group* and the other the *control group.* For the experimental group, the researcher changes one condition that is likely to affect the subjects' behaviour and holds all other factors constant. The experimenter does nothing to the control group. If the experimental group behaves differently from the control group, the one condition changed probably caused the difference.

Other experiments involve repeated testing of the same subjects under different conditions. For example, a study might test how alcohol affects people's driving. Each subject would take a driving test on a laboratory simulator while sober and then repeat the test after drinking a prescribed amount of alcohol. Any difference in performance would probably be due to the alcohol consumed.

The experimental method enables scientists to test a theory under controlled conditions. But many psychologists hesitate to form conclusions based only on laboratory investigations. In many cases, people's behaviour changes simply because they know they are part of an experiment.

### History

**Beginnings.** Since ancient times, philosophers and people in general have tried to understand why human beings and other animals behave as they do. The origins of psychology are often traced to the ancient Greek philosopher Aristotle, who was chiefly interested in what the human mind could accomplish. Aristotle believed that the mind or soul, which the Greeks called the *psyche,* was separate from the body. He thought the psyche enabled people to reason and was the source of the highest human virtues. The word *psychology* comes from the Greek words *psyche* (mind or soul) and *logia* (study).

During the Middle Ages, scholars studied behaviour chiefly from a religious rather than a scientific viewpoint. However, several philosophers of the 1600's and 1700's made contributions to the development of psychology. René Descartes, a French philosopher, described the body and mind as separate structures that strongly influenced one another. He suggested that the interaction between body and mind took place in the pineal gland, a tiny organ in the brain.

Descartes also believed that people were born with the ability to think and reason. This doctrine, called *nativism,* was rejected in the late 1600's and early 1700's by a group of philosophers called *empiricists.* These thinkers, including Thomas Hobbes and John Locke of England, David Hume of Scotland, and George Berkeley of Ireland, believed the mind is empty at birth. They thought that knowledge of the outside world comes only through the senses, and that ideas result from people's experiences in life.

**Psychology becomes a science.** In the mid-1800's, two German scientists—the physiologist Johannes P. Müller and the physicist and physiologist Hermann L. F. von Helmholtz—began the first systematic studies of

**A standardized test** helps measure abilities, aptitudes, interests, and personality traits. This psychologist is using a standardized test to help measure a child's learning abilities.

sensation and perception. Their work showed that the physical processes underlying mental activity could be studied scientifically.

But psychology did not develop into a science based on careful observation and experimentation until the late 1800's. In 1875, the American philosopher William James founded what was probably the world's first psychology laboratory. A similar laboratory was established in Germany in 1879 by Wilhelm Wundt. Wundt, a philosopher trained in medicine and physiology, also published the first journal of experimental psychology. The work of James and Wundt marked the beginning of psychology as a distinct field separate from philosophy.

From the late 1800's until the 1930's, psychologists were divided about what they should study and how they should study it. Four major schools developed. These schools were (1) structuralism, (2) behaviourism, (3) Gestalt psychology, and (4) psychoanalysis.

**Structuralism** grew out of the work of James, Wundt, and their associates. These psychologists believed the chief purpose of psychology was to describe, analyse, and explain conscious experience, particularly feelings and sensations. The structuralists attempted to give a scientific analysis of conscious experience by breaking it down into its specific components or structures. For example, they identified four basic skin sensations: warmth, cold, pain, and pressure. They analysed the sensation of wetness as the combined experience of cold and smoothness.

The structuralists primarily used a method of research called *introspection.* In this technique, subjects were trained to observe and report as accurately as they could their mental processes, feelings, and experiences.

**Behaviourism** was introduced in 1913 by John B. Watson, an American psychologist. Watson and his followers believed that observable behaviour, not inner experience, was the only reliable source of information. This concentration on observable events was a reaction against the structuralists' emphasis on introspection. The behaviourists also stressed the importance of the environment in shaping an individual's behaviour. They chiefly looked for connections between observable behaviour and stimuli from the environment.

The behaviourist movement was greatly influenced by the work of the Russian physiologist Ivan P. Pavlov. In a famous study, Pavlov rang a bell each time he gave a dog some food. The dog's mouth would water when the animal smelled the food. After Pavlov repeated the procedure many times, the dog's saliva began to flow whenever the animal heard the bell, even if no food appeared. This experiment demonstrated that a reflex—such as the flow of saliva—can become associated with a stimulus other than the one that first produced it—in this case, the sound of a bell instead of the smell of food. The learning process by which a response becomes associated with a new stimulus is called *conditioning.*

Watson and the other behaviourists realized that human behaviour could also be changed by conditioning. In fact, Watson believed he could produce almost any response by controlling an individual's environment.

During the mid-1900's, the American psychologist B. F. Skinner gained much attention for behaviourist ideas. In his book *Walden Two* (1948), Skinner describes how the principles of conditioning might be applied to create an ideal planned society.

**Gestalt psychology,** like behaviourism, developed as a reaction against structuralism. Gestalt psychologists believed that human beings and other animals perceive the external world as an organized pattern, not as individual sensations. For example, a film consists of thousands of individual still pictures, but we see what looks like smooth, continuous movement. The German word *Gestalt* means *pattern, form,* or *shape.* Unlike the behaviourists, the Gestaltists believed that behaviour should be studied as an organized pattern rather than as separate incidents of stimulus and response. The familiar saying "The whole is greater than the sum of its parts" expresses an important principle of the Gestalt movement.

Gestalt psychology was founded about 1912 by Max Wertheimer, a German psychologist. During the 1930's, Wertheimer and two colleagues took the Gestalt movement to the United States. For more information, see **Gestalt psychology**.

**Psychoanalysis** was founded during the late 1800's and early 1900's by the Austrian doctor Sigmund Freud. Psychoanalysis was based on the theory that behaviour is determined by powerful inner forces, most of which are buried in the unconscious mind. According to Freud and other psychoanalysts, from early childhood people *repress* (force out of conscious awareness) any desires or needs that are unacceptable to themselves or to society. The repressed feelings can cause personality disturbances, self-destructive behaviour, or even physical symptoms.

Freud developed several techniques to bring repressed feelings to the level of conscious awareness. In a method called *free association,* the patient relaxes and talks about anything that comes to mind while the therapist listens for clues to the person's inner feelings. Psychoanalysts also try to interpret dreams, which they regard as a reflection of unconscious drives and conflicts. The goal is to help the patient understand and accept repressed feelings and find ways to deal with them.

**Modern psychology** has incorporated many teachings of the earlier schools. For example, though many psychologists disagree with certain of Freud's ideas, most accept his concept that the unconscious plays a major role in shaping behaviour. Similarly, most psychologists agree with the behaviourists that environment influences behaviour and that they should study chiefly observable actions. However, many psychologists object to pure behaviourism. They believe that it pays too little attention to such processes as reasoning and personality development.

Psychology today has continued to develop in several directions. A group of extreme behaviourists called the *stimulus-response school* believe all behaviour is a series of responses to different stimuli. According to these psychologists, the stimulus connected with any response can eventually be identified. As a result, stimulus-response psychologists regard behaviour as predictable and potentially controllable.

Another group of psychologists, who are known as the *cognitive school,* believe there is more to human nature than a series of stimulus-response connections. These psychologists concentrate on such mental proc-

esses as thinking, reasoning, and self-awareness. They investigate how a person gathers information about the world, processes the information, and plans responses.

A school called *humanistic psychology* developed as an alternative to behaviourism and psychoanalysis. Humanistic psychologists believe individuals are controlled by their own values and choices and not entirely by the environment, as behaviourists think, or by unconscious drives, as psychoanalysts believe. The goal of humanistic psychology is to help people function effectively and fulfil their own unique potential. The supporters of this approach include the American psychologists Abraham H. Maslow and Carl R. Rogers.

Many psychologists do not associate themselves with a particular school or theory. Instead, they select and use what seems best from a wide variety of sources. This approach is called *eclecticism*.

**Related articles** in *World Book* include:

**Biographies**

| | |
|---|---|
| Adler, Alfred | Koffka, Kurt |
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| Bettelheim, Bruno | Pavlov, Ivan P. |
| Binet, Alfred | Piaget, Jean |
| Ellis, Havelock | Skinner, B. F. |
| Freud, Anna | Terman, Lewis M. |
| Freud, Sigmund | Thorndike, Edward L. |
| Fromm, Erich | Thurstone, Louis L. |
| Gesell, Arnold L. | Tolman, Edward C. |
| Harlow, Harry F. | Watson, John B. |
| Horney, Karen | Wundt, Wilhelm |
| James, William | Yerkes, Robert M. |
| Jung, Carl Gustav | |

**Major fields of psychology**

| | |
|---|---|
| Abnormal psychology | Learning |
| Clinical psychology | Motivation |
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| Developmental psychology | Personality |
| Industrial psychology | Social psychology |

**Other related articles**

| | |
|---|---|
| Behaviour | Psychotherapy |
| Gestalt psychology | Sensitivity training |
| Mental illness | Sociobiology |
| Motivation research | Testing |
| Parapsychology | Transactional analysis |
| Psychoanalysis | |

**Psychopathology.** See **Abnormal psychology.**

**Psychosis** is a term used to describe a severe mental illness. Psychoses are characterized by a variety of symptoms that most people consider abnormal. These include *hallucinations,* such as hearing voices when no one is around, and *delusions,* such as the notion that one is being persecuted or conspired against (see **Hallucination; Delusion**).

Some psychoses have obvious physical causes. For example, the brain may be diseased as the result of an infection such as *general paresis,* which is caused by syphilis, a venereal disease. Or, a physical illness of another part of the body may affect the brain, as in delirium due to pneumonia. These are called *organic psychoses.* In *toxic psychoses,* a harmful or poisonous substance (toxin) affects the brain. An example of this is a psychosis caused by lead poisoning. Other psychoses have no obvious physical cause. The most common psychosis is *schizophrenia* (see **Schizophrenia**).

See also **Mental illness** (Kinds).

**Psychosomatic medicine** is the use of the methods and principles of psychology in the treatment of physical ailments. The term is taken from the Greek words *psyche,* which means *mind,* and *soma,* which refers to the body.

Doctors have long known that emotional disturbances such as stress affect a person's body. For example, when a person is afraid or angry, adrenaline flows into the blood, increasing the action of the heart. Certain mental conflicts may make a person more susceptible to disease, or cause what appears to be a disease. Disorders that have been related to emotional disturbances include asthma, *peptic ulcer* (stomach ulcer), *rheumatoid arthritis* (inflammation and stiffness of the joints), *neurodermatitis* (chronic skin disorders), impaired resistance to infection, and *hypertension* (high blood pressure).

Psychosomatic medicine usually is not considered a special field of medicine. Most medical doctors have had some training in psychology and psychiatry. They often use psychological methods along with other methods of treatment. Some patients need help from doctors who specialize in psychiatry.

**Psychotherapy** is any treatment of mental or emotional disorders by psychological means. Most psychotherapy is based on discussions between a therapist and one or more patients.

There are three principal types of psychotherapists: (1) psychiatrists, (2) psychologists, and (3) psychiatric social workers. Psychiatrists usually have a medical degree and advanced training in the diagnosis and treatment of psychological disorders. Psychiatrists are the only psychotherapists permitted to prescribe tranquillizers and other drugs as part of the treatment. Most psychologists have a degree in psychology and practical training in psychology. Most psychiatric social workers have a degree and training in techniques of psychotherapy. Psychiatric nurses also may play a role in psychotherapy.

Psychotherapy includes a wide range of techniques based on different ideas and theories about the causes of psychological disorders. Some psychotherapists use one form of therapy for all their patients. However, many therapists vary their techniques to suit the nature of the patient's problems.

Scientists disagree over how much psychotherapy can accomplish for troubled individuals, but most agree that it can be helpful. There is no evidence that one form of therapy is more effective than any other. Much depends on the experience, skill, and warmth of the therapist, and on the relationship he or she establishes with each patient.

Most techniques of psychotherapy may be classified according to three general approaches: (1) analytical, (2) behavioural, and (3) humanistic. There are also other forms of psychotherapy, which cannot be classified in any of the three main categories. A psychotherapist who uses any approach may also use a technique called *group therapy.*

**Analytical psychotherapy.** The best-known type of analytical psychotherapy is *psychoanalysis,* a method of treatment developed by the Austrian doctor Sigmund Freud. Psychoanalysis is based on the theory that psychological disorders are caused by conflict between conscious and unconscious influences. For example, an

individual's sex drives may conflict with his or her moral standards. According to psychoanalysts, people develop methods called *defence mechanisms* to deal with conflicts that they cannot resolve. Perhaps the most common defence mechanism is *repression,* the forcing of unpleasant feelings or painful memories from the conscious part of the mind into the unconscious part. The goal of psychoanalysis is to bring repressed conflicts to conscious awareness. The patient may then be able to understand the conflicts and deal with them.

Psychoanalysts use several techniques to penetrate a patient's defence mechanisms. For example, Freud developed a method called *free association,* in which the patient relaxes and talks about anything that comes to mind. The therapist listens for clues to the individual's unconscious motives. Psychoanalysts also try to interpret dreams, which they regard as a source of symbolic clues to important unconscious feelings and conflicts. In addition, these therapists investigate the patient's life history, especially childhood memories.

There are a variety of methods of analytical psychotherapy other than psychoanalysis. For example, major variations of Freud's ideas and techniques were developed by Alfred Adler of Austria, Erich Fromm and Karen Horney of Germany, and Carl Jung of Switzerland. However, all analytical therapists focus on the interplay between the conscious and unconscious mind.

**Behavioural psychotherapy** is based on the concept that psychological problems result from a basic learning process called *conditioning.* In conditioning, a person learns to make specific responses to stimuli from the environment. According to behavioural theory, individuals who have psychological problems either have failed to learn effective responses to stimuli or have learned faulty behavioural patterns in dealing with stresses.

Behavioural therapists attempt to change a patient's self-defeating behavioural patterns by a variety of means. For example, the therapist may reward desirable responses and ignore or punish any other responses. Behavioural therapists also work to change patients' beliefs about themselves and their behaviour. The therapist may try to increase an individual's confidence in his or her own ability to function effectively. The therapist also may try to replace a patient's unreasonable goals with reasonable ones.

**Humanistic psychotherapy** emphasizes people's potential for growth and self-fulfilment rather than concentrating on their unconscious conflicts or their self-defeating behaviour. Humanistic therapists work to help patients develop personal awareness, self-understanding, and an appreciation of their own worth. The therapist does not probe the patient's past life, as a psychoanalyst does, or attempt to change specific behaviour, as a behavioural therapist does. Instead, the therapist provides an atmosphere of acceptance and support where the patient can explore his or her problems.

There are several types of humanistic psychotherapy. The most typical one is probably *client-centred therapy,* which was developed by the American psychologist Carl R. Rogers. Rogers thought the word *patient* implied illness, and so he referred to the person seeking help as a *client.* Client-centred therapy assumes that the troubled individual is the best expert for solving his or her own problems. The therapist repeats and restates the client's feelings and thoughts in an effort to help the person gain insight. The therapist does not try to explain the problem or tell the client what to do. According to Rogers' theory, clients can learn to make constructive choices by becoming more aware of their emotions.

**Other forms of psychotherapy** include (1) Gestalt therapy, (2) transactional analysis, and (3) reality therapy. Gestalt therapy, developed by the German psychiatrist Frederick S. Perls, is directed at bringing patients' thoughts and actions into harmony with their deepest feelings. In transactional analysis, the therapist helps patients analyse their relationships in family and social situations. In reality therapy, the patient is held responsible for his or her own behaviour and is forced to accept its consequences.

**Group therapy** is psychotherapy conducted with a group of patients, usually six or more persons. Any approach to psychotherapy may be applied in a group setting. For example, there are psychoanalytical therapy groups, behaviour therapy groups, and Gestalt groups. Group therapy has several advantages. A therapist can serve more people in a group than in individual sessions, and they can share experiences and learn from one another. The group also provides social and emotional support to its members in times of stress.

In a special form of group therapy called *family therapy,* one or more therapists work with the members of a family as a group. The therapists also may hold meetings with individual family members. Family therapists believe that even if only one family member seems to have a problem, all the members are involved in some way.

**Related articles** in *World Book* include:

| | |
|---|---|
| Adler, Alfred | Jung, Carl Gustav |
| Behaviour (Behaviourism) | Mental illness |
| Clinical psychology | Neurosis |
| Freud, Sigmund | Psychiatry |
| Fromm, Erich | Psychoanalysis |
| Gestalt psychology | Transactional analysis |
| Horney, Karen | |

**Psychrometer.** See Hygrometer.

**Psyllium** is a herb grown in southern Europe and India. It bears a seed that is used as a drug. The seed of the psyllium has laxative qualities and is used in medicines. When the seed is moistened, it looks like gelatin.

The psyllium is an annual herb and grows as high as 50 centimetres. Psyllium leaves resemble grass and are from 2.5 to 6.5 centimetres long. The psyllium has tiny flowers that are arranged in spikes, about 15 millimetres long.

**Scientific classification.** Psyllium belongs to the plantain family, Plantaginaceae. Common species are *Plantago psyllium* and *P. ovata.*

**Ptarmigan** is the name for a group of birds that resemble grouse. The ptarmigan is found in northern parts of the Northern Hemisphere, such as Alaska, Greenland, Iceland, Scotland, Scandinavia, and Siberia. Ptarmigans are also found high in the Alps and Pyrenees, European mountain ranges. Ptarmigans can be recognized by the covering of short feathers on their feet. These help the bird to walk on snow without sinking in. In winter the feathers of the ptarmigan are white, and the bird hides in snowdrifts for protection. In autumn the ptarmigan is grey above, with white under-

parts. In summer its plumage is reddish-brown and black.

The ptarmigan builds its nest on the ground. The nest is lined with grass or leaves. A female ptarmigan may lay from 5 to 10 eggs. The eggs may be cream coloured or red, covered with black or dark brown spots. The female sits on the eggs for 3 to 4 weeks. The young are able to fly 10 days after hatching.

The *willow ptarmigan,* also called willow grouse, makes its home in the Arctic region, Newfoundland, Canada, northern Europe, and Siberia. The *rock ptarmigan* lives in the Arctic region, from the Aleutian Islands to Greenland. It is found above the tree and shrub lines, among grass and herbaceous plants. The *white-tailed ptarmigan* lives in the Rocky Mountains of North America. It lives among shrubs, on high ground from central Alaska south to New Mexico.

**Scientific classification.** Ptarmigans belong to the grouse family, Tetraonidae. The willow ptarmigan is *Lagopus lagopus,* the rock ptarmigan is *L. mutus,* and the white-tailed ptarmigan is *L. leucurus.*

See also **Bird** (pictures: The ptarmigan hides from enemies; Birds of the Arctic).

**Pteranodon.** See **Pterosaur.**

**Pteridophyte,** also called *fern plant,* is one of a large and important group of plants that are simpler in their structures than flowering plants. The name *pteridophyte* means *fern plant.* Not all the pteridophytes are ferns, but ferns are the best known of the group, and many of the other pteridophytes look more or less like ferns.

The pteridophytes lack flowers but they have many of the same organs and habits that flowering plants have. Their tissues are distinctly divided into roots, stems, and leaves, as those of flowering plants are.

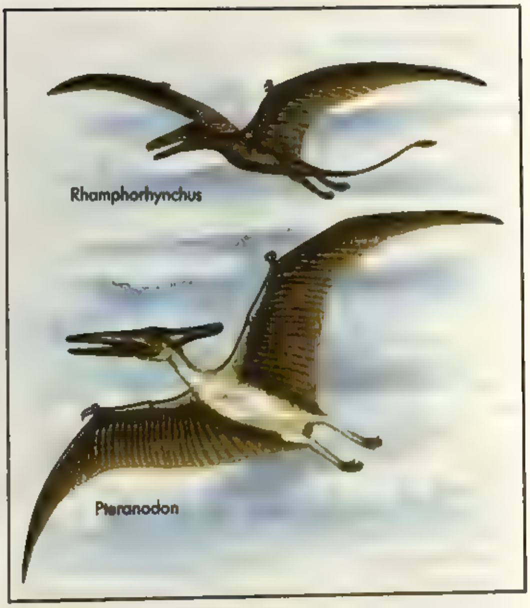
Instead of reproducing by seeds as flowering plants do, the pteridophytes multiply by means of very small bodies called *spores* (see **Spore**). These spores do not result from flowers, but grow on special parts of the plant in little cases. The spore cases of ferns are the roundish brown specks appearing on the back of certain of the fern leaves. When the spores drift away and start to grow, they produce small plants quite different from the ferns. After a time these small plants give rise to young ferns, which grow and produce another generation of spores. Other plants in the pteridophyte group, such as horsetails and club mosses, have a life history similar to that of the ferns.

Millions of years ago the pteridophytes were among the largest and most common kinds of plants. Many of the world's coal deposits are formed largely by the remains of pteridophytes. Fossil records show that many pteridophytes reached the size of large trees. But present-day kinds, except the tree ferns of the tropics, are small, non-woody herbs.

See also **Club moss; Fern; Horsetail.**

**Pterosaur** was a member of an extinct group of flying reptiles. Pterosaurs lived in the Mesozoic Era, from about 210 million to 63 million years ago. Their fossils have been found on every continent.

There were two major kinds of pterosaurs—*rhamphorhynchoids* and *pterodactyls.* Rhamphorhynchoids developed first. They had a short face and neck and a long tail. This group included some of the smallest pterosaurs, which were about the size of sparrows.




**Pterosaurs were prehistoric flying reptiles.**

Pterodactyls were more advanced and varied in size. They had a long face and neck, and were almost tailless. The *Pteranodon,* a large pterodactyl, had a crest at the back of the head. The largest known flying animal was a pterodactyl. It had a wingspan of between 11 and 12 metres.

At one time, experts believed that pterosaurs flew poorly and used their wings only for gliding. Most scientists now think pterosaurs were good flyers that flapped their wings up and down. Only some of the larger and more specialized forms seem to have been suited chiefly for soaring and gliding. Pterosaurs had light, hollow bones. Three clawed fingers and a long fourth finger extended from the end of each forelimb. Each wing consisted of a membrane that stretched from the side of the body to the tip of the fourth finger. Fine, parallel fibres prevented the wing from tearing. Fur may have covered the pterosaur's body and kept the animal from losing body heat. Pterosaurs may have been able to run on their hind legs, but they probably were clumsy on land.

Pterosaurs ate other animals. The smaller forms probably ate insects. Some of the larger pterosaurs fed on fish, lizards, and other small *vertebrates* (animals with backbones).

See also **Prehistoric animal** (pictures).

**Ptolemy** (A.D. 100?-165?) was one of the greatest astronomers and geographers of ancient times. He was also known as Claudius Ptolemaeus. Almost nothing is known about the events of Ptolemy's life. However, scholars have determined that he made his astronomical observations in Alexandria, Egypt, about A.D. 150. Ptolemy's observations and theories are preserved in a 13-part work entitled *Mathematike Syntaxis,* or *Mathematical Composition.* This work was so admired that it became known as the *Almagest,* a combination Greek-Arabic term meaning *the greatest.*

**Ptolemy**

In the *Syntaxis,* Ptolemy rejected the idea that the earth moves. He pointed out that the earth is round and that gravity is directed toward the centre of the earth. Ptolemy placed the motionless earth at the centre of the universe. Around it went the moon, sun, and planets at various rates of speed. Ptolemy believed that the stars were fixed points of light in a rotating sphere. Against this stellar background, Ptolemy traced the motions of the planets and worked out a theory for each of them. He stated that the planets are much closer to the earth than the stars, but are farther away than the moon. Ptolemy developed his system of astronomy largely from the ideas of the Greek astronomer Hipparchus (see **Hipparchus**).

Ptolemy's system of astronomy was accepted as authoritative throughout Europe until 1543. That year, the Polish astronomer Nicolaus Copernicus formulated his theory that the earth is a moving planet. Copernicus showed that many of Ptolemy's ideas were incorrect (see **Copernicus, Nicolaus**).

Ptolemy devoted two parts of the *Syntaxis* to a catalogue of the stars. He described a mathematical arrangement of the stars, and gave the celestial latitude and longitude for each of them. This catalogue included 1,022 stars, grouped into 48 constellations. Ptolemy also discovered the irregularity of the moon in its orbit. This irregularity is known as *evection.*

Ptolemy dealt with certain technical aspects of astronomy in his other writings. His serious treatment of astrology helped to spread that superstition. In *Optics,* Ptolemy discussed the refraction of light as it passes from one medium into another medium of different density. In addition, this book included a table of refractions.

Ptolemy's *Geography* opens with an excellent theory of map projection. The book contains a list of places with their longitudes and latitudes, as well as 26 colour maps and a map of the world. Ptolemy exaggerated the extent of land mass from Spain to China, and underestimated the size of the ocean. This mistake encouraged Christopher Columbus to make his famous voyage in 1492.

See also **Astronomy** (picture: The earth-centred theory).

**Ptolemy I** (367?-283? B.C.) founded a family of rulers who reigned in Egypt from 323 to 30 B.C. This family became known as the Ptolemies. Ptolemy I, who took the title of king of Egypt about 305 B.C., ruled until 285 B.C.

Ptolemy was born in Macedonia, a region north of Greece. He became a leading general in the army of Alexander the Great, a Macedonian king who built an empire that included Egypt and most of western Asia. After Alexander died in 323 B.C., Ptolemy gained control of Egypt. He extended his rule to the island of Cyprus, Judea (in the southern part of ancient Palestine), and Cyrene, a Greek colony in northern Africa.

Ptolemy helped Egypt become a strong, independent country. He introduced new crops and improved existing ones. He encouraged trade and regulated imports and exports. Ptolemy recruited Greek and Macedonian settlers for his army, navy, and administration. He gave the settlers land and encouraged the development of Greek culture in Egypt. Ptolemy founded a museum and library in Alexandria that helped make the city one of the world's great centres of culture and learning (see **Alexandrian Library**). He also founded the cult of the god Serapis, which combined Greek and Egyptian practices (see **Serapis**).

**Ptomaine poisoning** is an outdated term for a type of food poisoning. Ptomaines are nitrogen-containing compounds that are formed by the bacterial decomposition of proteins. Although ptomaines are present in spoiled foods, the human digestive system can completely neutralize them. It is the bacteria—or the *toxins* (poisons) that are produced by the bacteria—that actually cause "ptomaine" poisoning. Ptomaines are now classified in a group of chemicals that do not cause food poisoning. See also **Food poisoning.**

**Pu Yi** (1906-1967), often called Henry Pu Yi, was the last emperor of China. In 1911 and 1912, while he was still a child, a revolution overthrew his Manchu government and replaced it with a republic. Pu Yi was allowed to remain in Beijing, the capital. But in 1924, he fled from warlords to Japanese protection in the nearby city of Tianjin. In 1931, the Japanese seized a large part of northeastern China and made it a puppet state called *Manchukuo.* In 1934, they made Pu Yi ruler of Manchukuo. He ruled until the end of World War II (1939-1945). He was captured by the Soviets and transferred to the Communist Chinese, who pardoned him in 1959. Pu Yi was born in Beijing.

**Pub.** See **Public houses.**

**Puberty.** See **Sex** (Puberty); **Adolescent.**

**Public domain** means that the right to possess or own property belongs to the public rather than to an individual. Public lands that have never been privately owned are called public domain. Creative works and inventions that are not protected by copyright or patent are said to be *in the public domain.* Processes that have been generally known for many years also are in the public domain.

**Public education.** See **Education; Democracy** (Education and democracy).

**Public houses** are places where people can go to buy alcoholic or other cold drinks. Many public houses also serve food and hot drinks. They are usually referred to as *pubs.* If they also provide accommodation, public houses may be called *inns.* A public house has at least one room—the bar—where drinks are served at the bar counter. Most bars are comfortably furnished with chairs and tables, although many customers prefer to stand and drink at the bar counter.

In Britain and Ireland, people usually go to public houses to meet their friends and to enjoy a drink with them. Some people visit a nearby public house regularly.

The most popular public houses are those with a friendly and informal atmosphere, in which the customers can relax. The personality of the *publican* or *landlord,* who is in charge of the public house, often affects

**Public houses** in Britain and Ireland provide a convenient and friendly meeting place for people living nearby. Many people refer to their nearest public house as the *local.*

its popularity. Many public houses are decorated in an attractive style, which greatly increases their appeal.

### Ownership and control

Most public houses in Britain are owned by large breweries. These public houses are called *tied houses,* as the publican can only sell those brands of drinks specified by the brewery owning the house. Publicans of tied houses are either tenants, who pay rent to the brewery, or managers, who are employees of the brewery.

*Free houses* are owned by individuals who are not tied to a particular brewery. Publicans of free houses can sell any brand of drink they choose. In the Republic of Ireland, most public houses are free houses, and there are many others throughout Britain.

Sales of alcoholic drinks are controlled by a series of acts of Parliament referred to as the *licensing laws.* All publicans must have a licence from the local magistrates to serve alcoholic drinks. The magistrates grant a licence only under strict conditions, which ensure that only law-abiding people become licensees. The magistrates can withdraw a licence if the licensee is found guilty of serving short measures, of selling alcoholic drinks to children, or of keeping a disorderly house. Publicans have the right to refuse to serve a drink to anyone. But, by law, they must not serve alcoholic drinks to children under 18 years, nor allow children under 14 into the bar.

Licensing laws also control the times at which public houses may be open for the sale of drinks. Opening hours vary. Public houses may remain open for up to 12 hours on Monday to Saturday, during the day, and for up to 7 hours on Sunday, at lunchtime and in the evening. Magistrates may grant extensions to normal opening hours for special occasions. After closing time, customers are allowed 20 minutes for finishing their drinks. If the drinking-up time is exceeded, the customers and the publican may have to pay a heavy fine.

### Types of public houses

There are more than 60,000 public houses in the British Isles. Most are located in the centres of towns and villages. But many others lie outside towns, within sight of a main road, or what used to be a main road. Public houses vary considerably in size. Many are large enough to accommodate several hundred people, but some are smaller than an average-sized dining room in a private house. Smaller public houses are often located in more remote areas or in narrow side streets in towns. Some public houses have an outside area with chairs and tables known as a *beer garden.*

**Decorative styles.** Public houses can be identified by their names, which are often distinctive and are usually displayed on a swinging signboard outside. Many signs are painted attractively, illustrating the name of the public house. Common names of public houses include the *Red Lion* and the *Rose and Crown.* Among more unusual names are the *Cat and Custard Pot* and the *World Turned Upside Down.*


**A public house in Devon, England,** provides refreshment and entertainment for tourists as well as for local residents.

The exteriors of public houses vary according to when they were built. The *Fighting Cocks* at St. Albans, in Hertfordshire, England, has an exterior of medieval plaster. The *King's Head* at Aylesbury, in Buckinghamshire, England, is a Tudor-timbered building. Many more modern buildings are built of brick and decorated with brightly coloured blinds and shutters.

The interior decorations of some public houses reflect the nature of the surrounding area or the type of customers who come to the public house. Bars in some public houses located by the sea are decorated with fishing nets and sea shells or with pictures of boats. In public houses used by hunters in country districts, the decorations often include hunting prints and foxes' heads and *brushes* (tails).

**Facilities.** Public houses have certain facilities in common. Over the cellars, where supplies of drink are kept, are the bars. The largest of these is generally the *public* bar. Public bars are simply furnished. The *saloon* bar, or *lounge,* is usually more comfortably furnished. Public houses in country districts are often spacious and have several bars, but one-bar public houses have become increasingly popular. Some public houses have separate dining rooms where meals are served. But the majority of public houses that provide food serve hot and cold snacks in the bars. A few public houses also provide overnight accommodation. Many public houses have gardens where customers can sit in the summer to enjoy their drinks. Young children are allowed in these gardens and may be served with soft drinks.

Most public houses employ sufficient staff, apart from the publican, to provide customers with quick and efficient service. The staff serve drinks and food from behind the bar counter.

Traditional games are sometimes played in public houses, including bar billiards, darts, dominoes, and skittles. Other entertainments include jukeboxes and fruit machines. Some public houses have regular entertainers, like folk-singing groups or jazz bands.

Other licensed premises include golf clubs, country clubs, and working men's clubs. But unlike public houses, clubs are usually visited only by members, who pay a subscription to belong to the club.

### People and public houses

Public houses are used by many different groups of people. In some areas, use of public houses is almost entirely confined to men, although most public houses are frequented by both men and women of various ages.

In the business districts of most towns, workers often go to public houses at lunch time for a quick drink and a light meal. But the majority of people who visit public houses do so in their leisure time, when they can pass the time relaxing and enjoying themselves in pleasant surroundings.

### History

Public houses have developed from the Roman *tabernae* (wine shops). The tabernae were situated along the main roads and were marked by ivy bushes. The Saxons had alehouses, marked by poles, and, if the alehouses sold wine, added the bushes. This custom is the origin of the saying "good wine needs no bush." In Saxon times, alehouses and taverns were a common feature of the countryside.

**Typical of many public houses** in towns, this building on a street corner is distinguished by its unusual name and sign.

Some public houses were originally the guest houses that were a part of all abbeys and monasteries. These guest houses were built for the benefit of pilgrims and other travellers. After the dissolution of the monasteries, the guest houses remained, as independent inns. Some of them were run by nobles. The *Star Inn* at Alfriston, East Sussex, England, is part of a monastic *refectory* (dining hall) on a pilgrimage route. Many public houses today are called *The Bull.* This name derives from the time when monks, authorized by an abbot, maintained the guest house or inn. The abbot's licence as a churchman used to bear a *bulla* (seal).

Later, when travel by coach became important, coaching inns developed. *The New Inn* at Gloucester, England, is a fine example, dating from Tudor times. Such places became increasingly important during the 1700's and 1800's.

In Victorian times, nonresidential drinking houses developed, particularly in towns and cities. Working-class men would spend an evening drinking beer in a roughly furnished bar, while middle-class gentlemen sat in more comfortable surroundings, probably drinking spirits.

During the 1900's, public houses have gradually become places where many people go for entertainment as well as refreshment. Trends that have appeared in the later 1900's include the increased use of public houses

by young people, the serving of meals in pubs that traditionally sold only drinks, and the introduction of facilities for catering to families with children.

**Related articles.** See the illustrations in the *People* sections of the Ireland, London, and United Kingdom articles.

**Public law.** See Law (Branches; Law in the 1900's).

**Public library.** See Library.

**Public opinion** refers to the opinions or views of people in a community or country on issues of public interest or concern. Such issues may deal with any subject that is open to differing beliefs and attitudes. For example, it is a matter of *opinion* whether the nations of the earth should attempt to cooperate in some sort of international organization, and, if so, what form this organization should take. In matters of opinion, reasonable people may hold widely different viewpoints.

On the other hand, it is no longer considered to be merely a matter of opinion that the earth is a sphere rotating on an axis and revolving in an orbit around the sun. It is a matter of *fact,* which can be demonstrated and about which reasonable people do not differ.

When a problem affects a number of people, they will discuss it and argue about it. These activities help develop a common opinion, or *consensus.* When discussion is open or public, these matters are public opinions. Public opinion, in this sense, varies widely in its character and content. Public opinion may be merely the variety of individual opinions in the early stages of discussion, when issues are not sharply defined and people are not well informed about them. At other times, the opinions of many individuals may become similar enough to form a *majority opinion* or even a consensus, which determines the kind of action a group will take. A vote decided by the majority gives structure to the group opinion and makes it lawful.

There is no definite way in which public opinion affects the decision-making process of government leaders and groups. Elections of political leaders are one important way the public can express its judgment about a candidate. However, the process of shaping government policy is often slow and uneven. Expressions of opinion may influence politicians. But such expressions also may be disregarded because public opinion lasts only a short time, is emotionally charged, and usually represents the more visible and vocal portion of the population. The balance of the population, often called the *silent majority,* does not express its views as regularly or as visibly.

Nevertheless, one of the major concerns of a democratic society is to determine the extent and significance of the opinions held by individuals and groups. The most common technique today, the public opinion poll, is used to survey the opinions of a sample of the population. The accuracy of the results depends on the knowledge and skill of the pollsters in selecting the sample and in developing good interview questions. There is always some margin for error in the results.

### There is no one "public"

A *public* is any group of people within which a controversy arises. They are the people who take part in the controversy and who are, or may be, affected by the way in which the controversy is finally settled. This group may be fairly stable or organized, such as the residents of a local community or the citizens of a whole country. A public may also be made up of a number of individuals who are unorganized and hard to identify, but who for widely varied reasons have a common interest in the matter at issue. Sometimes a public may be so small and compact that discussion takes place almost wholly through conversation and speechmaking in face-to-face situations.

Today, however, when modern means of communication make vast numbers of people aware of controversial issues and common interests, publics tend to be large and impersonal. These publics involve people who are not known to one another and are widely distributed over the country, or even among a number of countries. The members of such publics rarely meet each other face to face or have much direct communication. They are held together by the press, radio, television, films, and other means of communication. These impersonal but powerful publics are numerous in today's highly complex society. Many of them have their own specialized means of communication—newspapers and magazines, sponsored radio and television programmes, and local and national organizations representing opposing sides in controversies about issues.

The same person may be a member of several of these publics at one time. An individual may thus take part in discussions on a number of different problems and develop opinions in one area that conflict with those held on other subjects. An opinion about some economic issue, for example, may not be wholly in agreement with other opinions about moral, religious, or political issues. Intense public controversies sometimes arise out of efforts to reconcile opinions about problems in one field with opinions in others.

### The process of forming opinion

Many factors affect the position people will take on any public issue. People's values and attitudes influence the opinions they hold. Some people are well informed or make an effort to become so, and others make quick judgments based on casual impressions. Some people act quite independently. Yet other people are influenced mainly by the views of their friends and associates. Equally well-informed people often form differing opinions because they interpret facts differently, or because they have different interests, desires, anxieties, and prejudices.

Some individuals, especially celebrities, frequently have much more influence than others in the process of opinion formation. Such a person often appears to know all the facts and to have an outstanding ability to determine how they should be dealt with. Thus, this person may boldly and aggressively urge people to support a particular idea or course of action. Leadership may also be taken by unknown or ordinary people who, either as individuals or as small groups, spread their ideas slowly by word of mouth. In time, they can make a deep impression on the opinion of the masses of people.

Events also may have a great effect on the forming of opinion if they are dramatic enough, near enough, or personal enough to attract the attention of large numbers of individuals. The Great Depression of the 1930's focused public attention sharply on the need for economic reforms. Unemployment and widespread need

**Public opinion** can help bring about various reforms by putting pressure on government leaders. The protesters shown on the left are calling for an end to the production of nuclear arms.

changed more opinions than hundreds of lectures, radio talks, editorials, or sermons ever would have done.

### Agencies of public opinion

An agency of public opinion is simply the carrier of information about public issues, and of views about these issues. The agency may be an individual, a group of individuals, or a mechanical device that helps them to communicate with other people.

**Word of mouth** was the original carrier of public opinion. It was only a step from friendly group discussions to the oration or the sermon, in which one person more skilled at thought and expression than the rest undertakes to organize and state the prevailing opinion on some particular issue or problem that is of interest to the group.

**The press.** Speeches, books, and pamphlets were the principal means of expressing opinion until the 1800's. Then newspapers appeared in large numbers and soon developed wide circulations. The newspaper became more powerful than any other agency as a carrier of public opinion. Magazines are also powerful in making public opinion.

The political cartoon is a powerful tool for expressing and moulding opinion in the press. The cartoonist can caricature prominent people and ideas, and thus can often express a point of view more bluntly and much more vigorously than it could be expressed in writing. Most cartoons appeal more to the emotions than to reasoned and informed analysis.

**The film** is another important agency of public opinion. It has the advantage of giving people a vivid and concrete presentation of people and events that otherwise could be known only through oral or printed reports. Audiences are introduced intimately to manners, customs, ideas, and ways of life that may be much different from their own.

Many screenplays also express a point of view toward issues. Newsreels, travel pictures, documentary films, and other special kinds of films have been widely used to spread news and propaganda. The visual approach often affects the emotions of the audience and generates a strong response.

**Radio and television** carry the voices and words of newscasters and commentators—and of newsworthy people themselves—directly into millions of homes throughout the world. Television can bring into the home pictures and sounds of events live as they occur. Radio and television have supplemented rather than replaced the newspaper and the film as carriers of news and opinion. The older means of communication have time to give a more studied, fuller version of events than can the immediate reporting to which radio and television are best adapted.

**Educational agencies.** Schools and other educational institutions have great importance among the agencies of opinion. Their importance lies partly in their ability to develop basic attitudes and points of view that have a great bearing on the opinions people will form about the issues that arise from day to day. They provide knowledge about social, economic, political, and other aspects of life, and equip people with the skills necessary to interpret information about current developments.

**Other agencies.** Special propaganda groups attempt to influence public opinion. The most important are those with political, economic, or religious interests. Less powerful groups create ethical, nationalistic, racial, literary, artistic, and other types of public opinion. See **Propaganda.**

Political opinion is made for the most part by or for the political parties. Every large political party has an elaborate propaganda machine. Even the government in power, whether local or national, feels obliged to create a public opinion favourable to itself so that its programme may be carried out.

The making of public opinion by economic groups is also important in modern society. Business and economic institutions constantly seek to create and maintain a public opinion favourable to their interests. Businesses use advertising, sales promotions, and public relations to create favourable public opinion toward their products and business itself. Labour groups,

farmer groups, and even consumers themselves are often organized for the purpose of developing public opinion powerful enough to have substantial influence.

### Public opinion and government

If people are going to live together in society, they must set up certain rules, regulations, and controls to give that society some permanent form. In this way, the society can carry on its life with little conflict or disorder.

In many early societies, and in some countries today, leaders have used force or violence to make the people accept the rules. In some cases, the mere threat of violence is enough. Some leaders have used fraud to deceive the people. To protect their people from fraud, governments have extended laws against this abuse to include unethical practices in medicine, advertising, selling, and other fields. See **Fraud.**

Propaganda and censorship are the most widespread governmental controls over public opinion. With propaganda, the government seeks to make people accept its programme and policies by persuading them that only such a programme will keep them out of danger, or win a war, or meet some other emergency. Propaganda is actually a means of creating public opinion, rather than simply controlling it. Censorship, which seeks to eliminate ideas and attitudes, is a negative control over public opinion. It is often coupled with *counterpropaganda,* designed to meet the threat of one particular idea with one more favourable to the government. See **Censorship; Propaganda.**

Democratic society regards an informed and intelligent public opinion as the best means of securing orderly conduct and cooperation among people. Public opinion becomes the ultimate controller of social goals, laws, and ways of life. The spread of education and the development of the newspaper, radio, and television have made it possible for more people to be well informed about issues and events in their society.

### Controlling public opinion

Every group ambitious to rule or to exploit the masses of the people attempts to capture and control public opinion. Democracy depends on a balance of power of different groups rather than upon the power held by one or a few groups. Its basic controls will therefore be designed to secure for its citizens freedom to know the facts about public matters, to secure full and free public discussion, and to make public decisions effective. In most countries, a number of such controls exist. Constitutions provide for a careful system of checks and balances.

Power is normally divided between the *executive* (government), the *legislature* (law-making body), and the *judiciary* (courts) of a country. Each body observes and may restrict the power of the other two. The legislature lays down laws limiting the power of the executive and the judiciary. The executive governs within those laws and may also appoint some judicial and legislative officers. The judiciary interprets the laws made by the legislature and may make a judgment in disputes involving the executive. All three bodies are necessary to administer a democracy.

In addition, most constitutions provide specific freedoms, including freedom of the *press* (newspapers and other media), freedom of speech, and freedom of *assembly* (political gatherings). In democratic countries, people are encouraged to make their opinions known through election campaigns and referendums. Public meetings, marches, and peaceful demonstrations may be held. Private organizations work to encourage individuals and groups to present their views.

An effective and progressive democracy depends on an enlightened public opinion. The surest and most constructive development of public opinion is education, both in the schools and in other agencies of public opinion.

Extensive and accurate information is democracy's greatest ally, just as it is the greatest enemy of antidemocratic forms of government. Such information helps people make sound, informed judgments. Then they will also find it easier to see through the aims and devices of those who attempt to manipulate public opinion for selfish interests rather than the public good.

See also **Advertising; Censorship; Propaganda; Public opinion poll; Public relations.**

**Public opinion poll** is a survey to find out the attitudes, beliefs, or opinions of a large number of people. The population covered may include millions of individuals. But only a small number of them are actually questioned. If they have been properly chosen, their opinions will usually accurately reflect those of the entire group.

Polls are conducted throughout the world. But they are most frequently taken in industrial countries with a democratic form of government.

### Who uses polls?

Public opinion polls are used chiefly by five types of groups: (1) news media, such as newspapers, magazines, television, and radio; (2) politicians; (3) business companies; (4) government agencies; and (5) social scientists. These groups generally use polls that are taken by private polling companies, university research centres, or government agencies. Some groups conduct their own polls.

**News media** publish or broadcast the findings of public opinion polls. The major television networks and national newspapers conduct their own polls. Broadcasting stations and newspapers also subscribe to polls conducted by private companies.

**Politicians** use polls to help them plan their election campaigns and keep track of their strength with the voters. Polls help elected officials make decisions by telling them how people feel about various problems and issues. Many political candidates and elected officials hire polling groups to conduct private polls.

**Business companies** use polls or surveys to help them manage their operations and sell their products. Some companies subscribe to special polls taken by private polling companies. Many advertising agencies conduct *market research surveys* that measure people's knowledge and opinion of a product.

**Government agencies** rely on polls for guidance in operating and evaluating their programmes. Such polls ask people's opinions on educational programmes, medical services, transportation, and other subjects.

**Social scientists** sometimes use polls when studying

**A public opinion poll** measures people's attitudes about various issues. A personal interview conducted by a trained interviewer, *above,* is probably the most reliable method of polling.

human behaviour. A psychologist might conduct a poll among different age groups to study differences in attitudes between younger and older generations.

### Conducting a poll

People who conduct public opinion polls are sometimes called *pollsters.* The work of pollsters involves five steps: (1) defining the goals; (2) selecting the *sample,* the individuals to be questioned; (3) designing the questionnaire; (4) interviewing the sample; and (5) analysing the results.

**Defining the goals** involves deciding what a poll will seek to find out and whom it will question. A poll may ask people's opinions about certain economic, political, or social issues. It may study people's attitudes toward various events, individuals, or situations. The group of people from which the sample is selected is called the *population* or *universe.* A population may consist of everyone in a city, state, or some other area. On the other hand, it may include only a certain group, such as factory workers, homeowners, or teenagers.

**Selecting the sample.** Pollsters select the sample so that every person in the population has as close to an equal chance to be included as possible. For example, in polls conducted through personal interviews, pollsters first divide the area to be surveyed into major geographic regions. Specific localities are then selected by chance. Within these localities, the pollsters select various neighbourhoods by chance. Interviewers then conduct several interviews in each of these neighbourhoods. Pollsters also choose which member of the household to interview on a random basis.

**Designing the questionnaire.** Pollsters ask two general types of questions—*closed* and *open.* A closed question asks the respondents to select their answers from two or more choices. An open question asks them to give their opinions in their own words.

Before pollsters conduct a poll, they prepare a questionnaire on the issue to be studied. Most pollsters then test the questionnaire by making a *pilot study* on a small number of people. By pre-testing, the pollsters can tell if the respondents understand the questions, and if the answers provide the kinds of information sought. They also find out if the order of the questions affects the way people answer them.

**Interviewing the sample.** Most pollsters question respondents directly, either in person or by telephone. Questioning respondents in person has two advantages. The first one is that the interviewer can be at least reasonably sure that the respondent understands the questions. The second advantage is that the interviewer can use cards or other displays that list the choice of possible answers.

Telephoning respondents is the fastest way to conduct a poll, and it is less expensive than personal interviews. Some polls involve questionnaires that are posted to respondents. But many people do not return these questionnaires, and so the results may not be representative of the entire population.

**Analysing the results.** Computers help quickly tabulate the pattern of responses to pollsters' questions. The most common tabulation shows the percentage of respondents who answered each question in a certain way. Analysis of the results can show how strongly people feel about various subjects and whether their opinions have changed since a previous poll. It can also show what differences of opinion exist between different segments of the population and how attitudes on different subjects are interrelated.

### Evaluating a poll

The reliability of a poll depends chiefly on the size of the sample and how it is drawn. Most national polls involve interviews with between 500 and 2,000 people, depending on the purpose of the poll. If scientific procedures are followed in selecting the sample, the pollster

can calculate *sampling error*. Sampling error is expressed as a range—a certain number of percentage points—above and below the reported finding of the poll. It is the range of results that could be expected if an infinite number of similar samples were polled on the same question. Sampling error depends on the size of the sample, not the size of the population.

Questions that are not fairly worded can also affect a poll's reliability. In addition, polls that have been sponsored by individuals who have something to gain by a certain result should be regarded cautiously.

### History

An early survey of public opinion was conducted in the United States in 1824. The *Harrisburg Pennsylvanian* asked voters in Wilmington, Delaware, who they thought would be elected president that year. On the basis of the poll, the newspaper predicted that Andrew Jackson would win. Jackson received more electoral votes than any of his opponents, but he did not get a majority. As a result, the election went to the House of Representatives, which elected John Quincy Adams.

Polls following scientific procedures were first used in 1935 with the experimental nationwide surveys of American pollsters George H. Gallup and Elmo Roper. Another American pollster, Archibald M. Crossley, began conducting scientific polling methods the following year. In 1940, the first academic centre for the development of polling techniques was established by Hadley Cantril at Princeton University, New Jersey, U.S.A.

In 1948, U.S. presidential election polls based on quota samples predicted that Governor Thomas E. Dewey of New York would defeat President Harry S. Truman. However, Truman won reelection in one of the greatest upsets in U.S. history. The polls failed for two chief reasons. The last polls taken were conducted too long before the election, and many voters probably changed their minds. Also, the pollsters' quota samples did not accurately represent the people who voted. After the 1948 election, most pollsters began to use probability sampling. This change, along with refinements in interviewing and other procedures, greatly increased the reliability of polls.

Since the 1970's, two special kinds of polls, called *tracking polls* and *exit polls*, have been widely used during elections. Tracking polls are conducted with small samples toward the end of an election campaign. Candidates use these polls to follow changes in their standing with voters. Exit polls are taken as people leave their voting places. The news media use the information collected in exit polls to help interpret the results of an election.

See also **Gallup, George H.; Market research; Public opinion.**

**Public ownership.** See **Government ownership.**

**Public relations,** commonly called *PR*, is an activity aimed at increasing communication and understanding between an organization or individual and one or more groups called *publics*. The term is also applied to the profession responsible for handling such assignments. Companies, educational institutions, religious groups, government agencies, trades unions, politicians, and entertainers are among those who use public relations. Their publics vary from employees and shareholders to an entire community or members of the news media. The communication between an organization and its public ranges from a simple news release to a sophisticated campaign featuring films, advertisements, speeches, and television appearances. Such communication is aimed at gaining the goodwill of the public.

Public relations generally is practised through (1) corporate public relations departments, (2) public relations agencies, and (3) public information departments. In a corporate PR department, specialists handle PR activities for only that company. In PR agencies, specialists carry out activities for several organizations or individuals, also called *clients* or *accounts*. Such nonprofit organizations as colleges and government agencies have public information departments that work to strengthen the image of the organization.

**Methods.** Public relations work consists of two main activities, *research* and *communication*. Research is a vital part of public relations because an organization may not know the public's opinion about it. What people think and why they have such opinions about an organization are important in helping management establish policies and practices. Public relations experts use research and opinion surveys to obtain information from the public. Researchers gather information on the many problems and opportunities facing a company, its industry, and the business community. They may gather information on public opinion so that a political candidate will know what issues to discuss during a campaign. Researchers also test the effectiveness of a PR campaign. In addition, they keep up with public relations techniques being developed by other companies.

Communication between an organization and the public is an important part of any public relations campaign. However, the size and complexity of most modern organizations make direct communication with individuals almost impossible. Most organizations use mass-communication methods to contact the public. These organizations often aim their PR campaigns at groups of people who share a common interest.

PR specialists use four principal methods to communicate with the public: *advertising, lobbying, publicity,* and the use of a *press agent*. Advertising involves the use of paid, nonpersonal communication through such media as posters, the mail, newspapers and other publications, radio, and television. Lobbying is an attempt to influence the voting of legislators to support the interests of an organization. Publicity and the use of a press agent involve promoting an organization by obtaining favourable coverage in the media.

**History.** Some elements of public relations, such as informing and persuading, have been used throughout history. Public relations as it is known today began to take form after the end of World War I in 1918. During the late 1800's, rapid and unchecked industrial expansion in many countries had brought about certain business attitudes and practices that were not in the best interest of the public. These conditions led to criticism of business in the early 1900's. Company leaders realized that their desire for bigger profits had increased such criticism. They felt that the goodwill of the public would benefit them. Business leaders also were aware of the successful public relations campaigns carried out by governmental departments and by welfare agencies in

some countries in winning approval for their aims. Corporations began to set up programmes designed to win the public's favour. Schools, hospitals, and other nonprofit organizations also saw the need for organized attempts to gain public support.

Public relations developed slowly until the end of World War II in 1945. Since then, it has spread to nearly every large commercial and nonprofit organization. The growth and expansion of mass communication media has tended to make public opinion more powerful than ever before. The public is also more accessible than ever to those who wish to reach it. That access is aided by the work of public relations.

**Related articles** in *World Book* include:

| | | |
|---|---|---|
| Advertising | Propaganda | Public opinion |
| Communication | Public opinion | poll |

**Public revenue** is funds raised through taxation to pay the expenses of government. See **Local government; Taxation.**

**Public school.** See **Education; United Kingdom, Educational systems of the.**

**Public speaking.** Training in effective public speaking is an essential part of training for leadership in any field of activity. Speakers who have a good purpose and are successful in attaining it are said to be *effective.* If they try to make factual information clear, they are effective when the members of their audience understand the facts. If they try to persuade members of the audience to agree to do something or to change their opinions, the speakers are effective when members of the audience decide to take the action or when they do change their minds. If speakers try to amuse the audience, they are effective when the audience shows by applause or laughter that they are being entertained.

## Approach to a speech

Speakers must consider four points: (1) their subject, (2) their audience, (3) themselves as speakers, and (4) their occasion.

**Subjects.** The speaker's direct and indirect experiences are the two general sources of speech subjects. *Direct experience* is knowledge obtained by actual participation in events, through personally seeing, hearing, feeling, tasting, and smelling. *Indirect experience* is knowledge obtained through listening to the experiences of others and through reading what others have written. Speakers can usually make a more effective presentation with subjects from their direct experiences than with subjects taken from someone else. Subjects should stimulate speakers to their best efforts. At the same time, they must appeal to the audience and be keyed to the knowledge and experience of the listeners.

**Audiences.** Speakers who talk about their subjects in terms of their own knowledge and their own wants, without regard for the knowledge and the wants of their audiences, are almost sure to fail. As a first step, speakers should find out what the members of their audience already know about the subject. The problem of explaining the operation of a new fireless and heatless electric stove to a group of electrical engineers is very different from explaining it to an audience of people who know little about electricity.

The speaker who attempts to persuade an audience of students to study economics should know their attitudes or opinions about studying economics. If speakers know beforehand that their audience is strongly opposed to believing or doing what they propose, then they recognize that they face a different and much more difficult problem from that of persuading a neutral or slightly favourable audience.

Speakers should also know whether the members of their audience want to hear about a subject. People usually listen only when they think the speaker's ideas will be of some benefit to them through satisfying one or more of their wants in whole or in part.

**Speakers.** The speaker's personality is probably the most important single factor in influencing audiences. Speakers should always give some consideration to themselves.

**Occasions.** Speakers should think carefully about the time and place of their speeches. Is the occasion appropriate for the subject they have chosen? The meeting of a sailing club would hardly be an appropriate occasion for a speech designed to sell household appliances. But such a meeting would be appropriate for a speech designed to raise money for new sailing boats.

## Planning the speech

When speakers have given careful thought to their subjects, their audience, their own personality, and the occasion, they are ready to plan the speech itself.

**Purpose.** Speakers should first select their general purpose. Do they wish to present factual information only, or *inform?* Do they wish to change beliefs or actions, or *persuade?* Or do they wish to amuse, or *entertain?* With their general purpose in mind, they should prepare a brief statement of their specific purpose. Examples of specific purposes are:

| | |
|---|---|
| *Informative.* | Tell a class how to play chess. |
| *Persuasive.* | Convince an audience that national governments ought to provide the necessary funds and facilities to ensure that the arts and other cultural activities will continue. |
| *Entertaining.* | Amuse a school assembly with a discussion of the habits of teachers. |

**The main ideas.** The next step should be to select the main ideas, or main divisions of the subject, as stated in the specific purpose. In informative speeches, the main ideas should define the specific purpose by answering the questions *who? what? where? when? why?* and *how?* In persuasive speeches, the main ideas ought to be the principal reasons for the desired belief or action. In entertaining speeches, the main ideas should be the divisions of the subject that can be amusing to the audience.

**Supporting material.** After selecting the main ideas, speakers should choose supporting material. This includes such things as *description, narration, comparisons, examples, testimony, statistics, visual aids* (charts, diagrams, demonstrations, slides, maps, films, photographs, samples, or working models), and *repetition* (restatement of important ideas to increase the chance that they will be remembered).

The selection of main ideas and supporting material completes the *body* (main part) of the speech.

**Introduction.** Speakers should next plan the introduction. This usually has two parts, the opening and the

statement of the specific purpose. In the *opening,* speakers catch the attention of their audience and arouse interest in their subject. In their *statement of specific purpose,* they tell the audience precisely what they intend to do in their speech.

**Conclusion.** Next comes the preparation of a conclusion. In informative speeches, this part should be a summary of the main ideas and specific purpose. In persuasive speeches, the conclusion should combine a summary with a final appeal to the audience to accept the arguments offered. Entertaining speeches usually end on a point of great amusement, without any type of formal conclusion.

**Outline.** After all these steps, speakers should prepare an outline, setting out in an organized and concise way the important elements of the speech. The outline should summarize, clearly and briefly, the introduction; the body, with the main part of the speech; and the conclusion.

Speakers may deliver their talks directly from the outline, or they may use the outline as the basis for a written speech. Skilled speakers usually prefer to speak from the outline, without writing the whole speech down. A speech delivered from an outline, without being memorized, is said to be delivered *extempore,* or *extemporaneously.* Extempore speeches should not be confused with *impromptu* speeches, which are made without any previous preparation, often without notice.

When preparing a speech for delivery, speakers should be careful to develop habits that will be helpful when the speech is presented. They should learn to walk gracefully and stand erect. They should talk directly to individual members of their audiences, speak loudly enough to be heard with ease, and vary the pitch and volume of their voices and their rate of speech to avoid being singsong or dull.

For the history of public speaking, see the article on **Oratory.** See also **Debate; Speech.**

**Public transport.** See **Transportation** (Public transportation).

**Public trustee** is a government official who acts as a trustee of people's estates in England and Wales. In a will, a person can appoint the public trustee as *executor* to carry out the provisions of the will; as *trustee* to manage the funds left in trust; or as *custodian trustee* to look after the trust property without managing it. The public trustee office was set up in 1906.

**Public utility** is a business which provides an essential service to the public. Public utilities include telephone, telegraph, electricity, gas, water, and waste disposal services. Public transportation systems such as airlines, bus companies, and railways are also public utilities. Many public utilities have a monopoly on their particular service within a given area. Many public utilities operate under government regulation or ownership, though many are privately owned.

Public utilities make up a major group of industries in the world economy. They account for a large share of the total assets of *nonfinancial businesses* (all firms except banks, insurance companies, and similar institutions). Among nonfinancial businesses in many countries, public utilities rank second only to the manufacturing group in total assets.

As countries become increasingly industrialized, urbanized, and interdependent, public utility services have become more important for the smooth functioning of economic activity. Interruption of any public utility service is considered a crisis.

**Ownership.** In many countries, as the name suggests, public utilities are owned by the *public sector* (government). In Europe many essential services were nationalized after World War II (1939-1945). Public corporations were established to run these services as a business. But since the early 1980's a growing number of governments all over the world have been selling off utilities which are now being run by the private sector. In these cases, the government usually continues to regulate the industry to make sure that quality is maintained and price rises are reasonable. Private companies have generally operated utilities more cheaply and more efficiently than the public sector.

Public utilities are often called *natural monopolies.* In a given area, one company can often provide a service more efficiently and at lower cost than could several competing companies. In a country in which few people possess a telephone, competition in the telephone industry, for example, would be costly and inefficient, because it would require several sets of telephone poles instead of a single set. The nature of the service provided by a public utility makes a monopoly desirable.

Certain features of public utilities save money for the public. Many public utility services are supplied under conditions of *decreasing cost.* That is, the unit cost of the service to the individual goes down as the service or number of customers increases. In addition, the prices of public utility services are regulated by government agencies.

**Regulation.** Government regulation of public utilities is necessary because they have a monopoly on a service. The aim of utility regulation is to make sure that consumers have adequate supplies of high-quality service at the lowest prices that will still permit the utility company to make a reasonable profit. Most utility regulations are set down in a permit, certificate, or franchise granted by a governmental unit. The company receives the exclusive right to serve a given market. The company also usually must get permission from the regulating authority to reduce, withdraw, or change its service.

**History.** Public utilities in the modern sense can be traced to early English *common law.* Common law designated certain activities as "peculiarly affected with the public interest." Included were docks, inns, warehouses, ferries, and canal companies. These activities were regulated by court decision, and not by legislation or public-service commissions.

**Related articles** in *World Book* include:

Franchise
Government ownership
Local government
Monopoly and competition

**Publicity.** See **Advertising; Public relations.**

**Publishing** is the process of preparing, manufacturing, and distributing books, magazines, newspapers, or other printed materials. This article describes book publishing. For information on magazine and newspaper publishing, see **Magazine** and **Newspaper.**

Book publishing is a relatively small industry, but has enormous importance in the educational and cultural

life of society. Books are the living record of human history and knowledge. They are the basic means of passing along the essential data of civilization from generation to generation. In addition, books provide pleasure and relaxation for many people. Many films and television dramas were adapted from books.

The person or group who directs the business of publishing a book is called the *publisher.* A publisher is responsible for obtaining and editing the manuscript of the author or authors. The publisher supervises the printing and binding of the manuscript, and distributes it to the public. Most of the work is performed in a company called a *publishing house.* A publishing house may have hundreds of employees working in large office buildings, or it may consist of only one person who does all the work in a single room.

People have made and sold books since ancient times. However, book publishing as a large industry did not begin until the 1800's. For a description of the development of book publishing, see **Book** (History).

### Kinds of book publishing

Publishing can be divided into three areas, each based on a specific type of book. The areas are generally known as (1) trade books, (2) educational books, and (3) reference books.

**Trade books** are books intended for the general reader. These books include novels; picture books for children; biographies; books on current affairs, history, or psychology; travel guides; cookery books; and "do-it-yourself" books.

Trade publishers distribute most of their books through bookshops and the book departments of other stores. Some trade publishers also distribute books through *book clubs,* which people join to get certain selected books, usually at reduced prices.

**Educational books** are published by special publishers or by educational departments of trade publishers. These books are the textbooks used for instruction in schools and colleges. Educational publishers often employ teachers and educators to plan and write their textbooks. In order to keep information in classrooms current, educational publishers regularly produce updated editions of the textbook. Educational publishers sell some of their books directly to schools. They also distribute their books through college and university bookshops.

Educational publishing is probably the most profitable area of book publishing. A great number of teachers and students are required to buy certain textbooks for their classes. A successful textbook can sell millions of copies over many years. Many publishers use the profits from educational books to publish trade books that may have uncertain sales prospects.

**Reference books** include encyclopedias, dictionaries, yearbooks, and similar books that contain information about a wide variety of topics. The material is organized so that the user can find facts quickly and easily. Most reference book publishers hire specialists to serve either as authors for the topics or as consultants for general areas of knowledge.

The production of reference books can be expensive, especially if the works consist of several volumes. But many of these books enjoy large sales to libraries, where people go to look up information. Reference books are also sold to individuals and families who want to have sources of information readily available. Many reference publishers use sales representatives who demonstrate and sell the books in the home. Some reference publishers allow their clients to pay for the books in instalments.

### Publishing a book

An author's manuscript goes through several stages of preparation before it reaches the reader in book form. Most publishers follow the same basic steps.

**Acquiring the manuscript.** Some authors of manuscripts hire *literary agents* to represent them. An agent first tries to find a suitable publisher for the manuscript. The agent then helps negotiate the author's financial arrangements with the publisher. Some agents also make deals allowing parts or all of the book to appear in magazines or as television or film adaptations. For these services, the author pays the agent 10 to 15 per cent of the author's income from the book.

Most publishing houses employ editors who have the responsibility of acquiring manuscripts for publication. They will watch for likely subjects and authors, and negotiate the purchase with both authors and agents. They discuss the terms by which the company will produce and market the book.

The publisher signs a written contract with the author specifying the *advance* and *royalties.* An advance is a sum of money that the publisher, in effect, loans to the author while the book is in preparation. The advance is subtracted from the royalties, which are payments that the publisher makes to the author from profits gained from the sale of the book. The publisher pays the author a certain percentage of the price of the book for each copy sold. The contract also names a date for publication and indicates who owns the *copyright,* which establishes the legal rights to control the book's publication (see **Copyright**).

**Editing the manuscript.** After obtaining the manuscript, an editor prepares it for publication. Editing is the process of putting the author's writing into "publishable" form.

The editor looks for parts of the manuscript that call for clarification or reorganization. Spelling, grammar, punctuation, and other elements of style may need to be corrected or altered. Some publishers also have policies or guidelines for the length, organization, and content of their books. The editor may have to verify the accuracy of certain facts in the manuscript. Editing may mean adding or omitting parts, or even rewriting the entire manuscript.

Some publishers divide the editing responsibilities among several people. For example, one editor obtains the manuscript and clarifies its content. Another person may edit it for proper style. Someone else may research all the facts.

**Designing and printing.** After the manuscript has been edited, it is ready for the designer. The designer is responsible for the overall appearance of the book, including the cover. An attractive book cover can arouse a person's interest in buying the book. The designer may also develop illustrations to accompany the text, including photographs, drawings, charts, and diagrams. For

most books, either a designer at the publishing house or a specially commissioned artist provides the illustrations and cover design. The designer blends the artwork with the edited text in an organized, readable way. In many cases, the designer will work with the author, editor, and other people involved in preparing the book for publication.

After the designer completes his or her work, the book is ready for typesetting and printing. Publishers once printed and bound their books in their own printing plants. But after the industry expanded, printers developed huge, modern presses that produced thousands of copies per hour. Today, most book publishers send the prepared material to such presses outside the publishing house.

Before a book is printed, a typesetting company sets the book in type and sends copies, known as *galley proofs* or *galleys,* back to the publishing house. At the publishing house, proofreaders check the proofs for errors. The author may also add some additional material. The publisher then returns the corrected galley proofs to the typesetters, who send the type to the printer for use on the presses.

A book exists in either *hardbound* or *softbound* form. Most hardbound books have covers made of cloth, plastic, or leather over cardboard. Softbound books, or *paperbacks,* have paper covers. Some books are produced first in hardbound form and later reprinted as paperbacks. Other books are published only as paperbacks. Normally, paperbacks cost less than hardbound books.

**Marketing the book.** Plans for advertising and distributing begin long before the book comes off the presses. Researchers in the sales department try to estimate the potential readership for the book. Sales representatives collect orders from bookstores and libraries to determine how many copies the printer should produce in time for the official date of publication. Accountants estimate the amount of money that the publisher should spend on advertising and promoting the book.

Publishers have various ways of advertising the book. Publicity specialists may schedule interviews for the author in newspapers and magazines and on television and radio shows. They also send galley proofs of the book to selected literary reviewers in hopes that favourable reviews will reach the public about the date of the book's publication.

As part of their advertising strategy, trade publishers may give advance copies of a book to political figures, television celebrities, or other influential personalities who might praise the book to the public. The publisher may also send the author on tours of bookstores to autograph copies for customers. Researchers watch the progress of sales to determine if and when the publisher should order another *printing* (new copies) from the printer.

**Related articles** in *World Book.* For biographies of publishers, see the *Related articles* at the end of Journalism and Newspaper. See also:

Bibliography
Book
Bookbinding
Copyright
Encyclopedia
International standard book number
Library (Challenges and problems; History)
Magazine
Printing
Type
Writing

**Puccini, Giacomo** (1858-1924), was an Italian opera composer. He ranks as one of the greatest opera composers of all time, alongside Wolfgang Amadeus Mozart, Richard Strauss, Giuseppe Verdi, and Richard Wagner. Audiences can hear such Puccini operas as *La Bohème* (1896), *Tosca* (1900), *Madama Butterfly* (1904), *The Girl of the Golden West* (1910), and *Turandot* (first performed in 1926, after Puccini's death). Opera companies also present *Il Trittico* (1918), a collection of three one-act operas—*Il Tabarro, Suor Angelica,* and *Gianni Schicchi.*

Puccini was born in Lucca, the fourth generation of a family of professional musicians. After studying music—unwillingly at first—he became a church organist. With a grant from Queen Margherita, Puccini enrolled at the Milan Conservatory in 1880. He submitted his first opera, the one-act *Le Villi,* in a competition, but did not win. However, the opera was produced successfully in Milan in 1884. His second opera, *Edgar* (1889), was less well received.

With the triumph of his opera *Manon Lescaut* (1893), Puccini began to gain a reputation as the probable successor to the aging composer Verdi. All 10 of the Puccini operas that followed won international fame for their mastery of theatrical effect, their emotionally charged melodies, their orchestral brilliance, and their attention to detail. Of the works Puccini composed after 1893, only *La Rondine* (1917), which is almost a musical comedy, has lost popularity. Puccini was working on the last scene of *Turandot* when he died in Brussels, Belgium. *Turandot* was completed by the Italian composer Franco Alfano.

See also **Opera.**

**Puck,** or Robin Goodfellow, a mischievous spirit or elf in English folklore, tormented people, usually in fun. He was also called Hobgoblin, and in 1595, Edmund Spenser, in one of his poems, included *the Pouke* among evil spirits. In *A Midsummer Night's Dream,* William Shakespeare presented him as a good-hearted elf. Enjoying his pranks on human beings, Puck exclaimed, "Lord, what fools these mortals be!" Puck figures prominently in Rudyard Kipling's *Puck of Pook's Hill* and *Rewards and Fairies.*

Watercolour (1785) by William Blake; Tate Gallery, London

**Puck,** *third from left,* was one of the main characters in William Shakespeare's romantic comedy *A Midsummer Night's Dream.* This painting shows Puck dancing for Oberon and Titania, the king and queen of the fairies, *left.*

**Puebla** is a state in east-central Mexico between Mexico City and the Gulf of Mexico (see **Mexico** [political map]). Puebla has a population of 4,126,101 and an area of 33,902 square kilometres. Mexico's three highest mountains, Orizaba (Citlaltépetl), Popocatépetl, and Ixtacihuatl, stand on Puebla's borders. Puebla farmers grow barley, maize, green peppers, peanuts, potatoes, rice, sugar cane, and wheat. Puebla also produces apples, plums, and other fruit. It is also a textile centre. The city of Puebla is the capital.

**Puebla** (pop. 1,007,170), officially Puebla de Zaragoza, one of the largest cities in Mexico, stands 105 kilometres southeast of Mexico City. It is the capital of the state of Puebla. For location, see **Mexico** (political map). Puebla has many beautiful Spanish-style churches and other buildings dating from the time when Mexico was a Spanish colony. The city's chief products include cotton textiles, glass, fine pottery, and beautifully coloured tiles. Founded in 1531, Puebla is one of the oldest Spanish settlements in Mexico.

**Pueblo,** ship. See **Korea** (North-South relations).

**Puerto Rico** is an island in the Caribbean Sea about 1,600 kilometres southeast of Florida, U.S.A. It is a *commonwealth* (dependent territory) of the United States. Its official name is Commonwealth of Puerto Rico.

Apart from Puerto Rico itself, the commonwealth also consists of a group of smaller islands. Chief among these are Vieques and Culebra. Puerto Rico's pleasant climate, sandy beaches, and resort hotels attract many tourists from the United States mainland.

Puerto Ricans are U.S. citizens, and can move to the mainland without immigration restrictions. When living on the island, however, they cannot vote in U.S. presidential elections and do not pay federal income taxes.

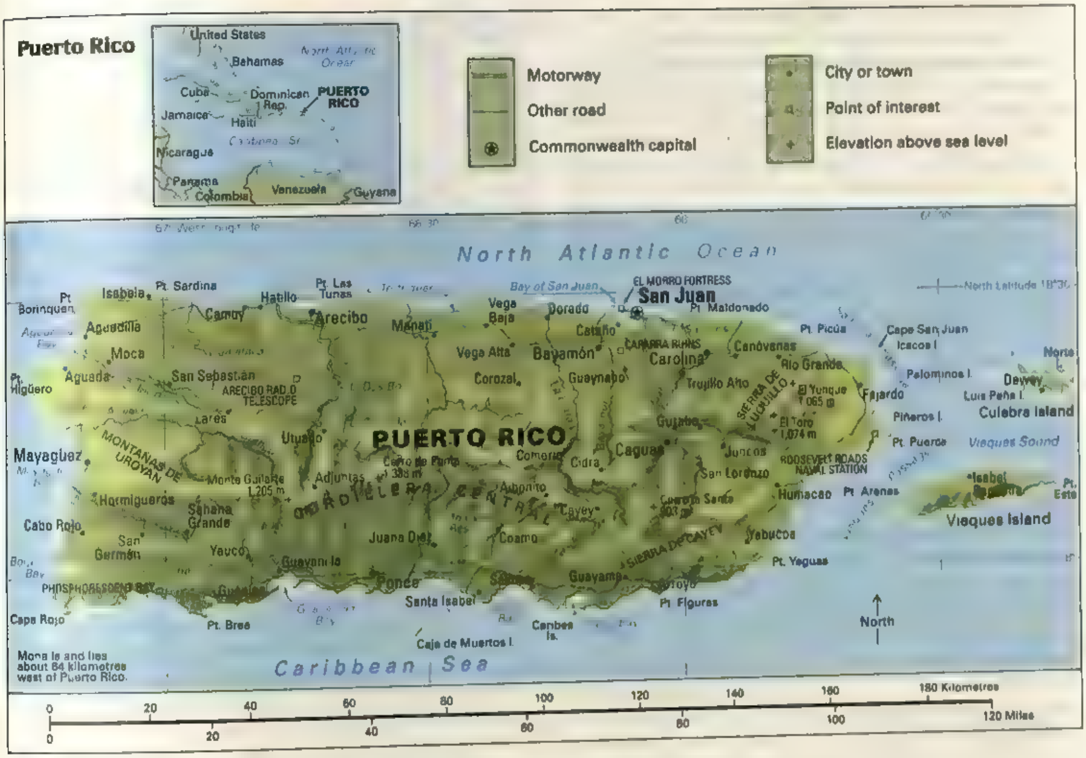
**Government.** The Commonwealth of Puerto Rico is considered to be a piece of territory within the United States but has complete internal self-government. It has a *bicameral* (two chamber) parliament—a 53-member House of Representatives and a 27-member Senate. The people elect the members of both houses. A governor elected by Puerto Rico's residents runs the administration of the commonwealth and signs all legislation into law. This official appoints a group of cabinet ministers on advice from the Puerto Rican Senate. The House of Representatives and the Senate both have the right to put forward most types of bills, but only the House of Representatives can present bills concerned with raising revenue. The governor must sign all bills before they can become law. A resident commissioner represents Puerto Rico in the U.S. House of Representatives, the lower house of the U.S. Congress. Puerto Rico's judicial system consists of the Supreme Court, superior courts, and district courts. For local government, the Commonwealth of Puerto Rico is divided into 78 municipal districts.

**People.** For the population of Puerto Rico, see the *Facts in brief* table with this article. Puerto Rico is a crowded island. About two-thirds of the people live in urban areas. More than half of them live in the metropolitan areas of Arecibo, Caguas, Mayagüez, Ponce, and San Juan. Puerto Rico's capital and largest city, San Juan, is a seaport on the north coast. The San Juan metropolitan area includes Bayamón, the second largest city. Ponce, the third largest city, is a commercial and cultural centre on the south coast.

The first inhabitants of Puerto Rico were Arawak people, who had arrived originally from South America. No full-blooded Arawak are now known to live in Puerto Rico. But some Puerto Ricans are descended from Arawak who intermarried with Spanish settlers. By far the largest part of the present population is of Spanish or African descent. The majority of Puerto Ricans speak Spanish, but many also speak English. Since January 1993, Spanish and English have been joint official languages of Puerto Rico. About 85 per cent of the population are Roman Catholics. Most of the rest are Protestants.

**Education.** Puerto Rico's Department of Education runs the island's primary and secondary schools. Students must attend primary and secondary school for the

**El Morro Fortress** stands on a bluff overlooking the Bay of San Juan. Spaniards built the fort between 1539 and 1787.




University of Puerto Rico, which is the state university, has three campuses and six regional colleges. The Catholic University in Ponce and the Inter-American University in San Germán also provide higher and further education courses.

**Way of life.** Puerto Ricans are bound by exceptionally close family ties. People who live in the towns inhabit large houses or high-rise blocks of flats. Housing in the outer suburbs of the towns, where a majority of the population live, is inadequate. A large number of slums or ghettos have developed in these areas, inhabited by poor families and subject to crime and violence. In Puerto Rico's rural areas, people live in small houses or cottages.

**Recreation.** U.S. sports, such as basketball and baseball, are popular with a wide cross-section of the whole Puerto Rican community. Many Puerto Ricans and visiting tourists enjoy such recreations as deep sea fishing, scuba diving, and water skiing. Cock-fighting, illegal in many countries, is popular in Puerto Rico.

Puerto Ricans are fond of fiestas and festivals. Each town has its own patron saint and commemorates the saint on the appropriate anniversary. The Saint's Day festivities include dancing, singing, gambling, parades, games, and religious worship. There are many annual commemoration days. Three of the most important are Three Kings Day (January 6), on which people exchange gifts; Discovery Day (November 19), the anniversary of the arrival of Christopher Columbus; and Constitution Day (July 25), when people celebrate the adoption of Puerto Rico's constitution in 1952.

**Arts.** Music is an essential part of the culture of Puerto Rico. *Décima,* the folk music of the island, is a vocal music in which the singers make up rhyming songs about events or personalities to a rhythmical accompaniment. *Plena,* associated with the African element of the population, is more political in content, rather like *calypso* or *soca* of other Caribbean islands. A plena festival takes place in June. Reggae, rock, rap, and American country music are also popular.

The Casals Festival, founded by the famous cellist Pablo Casals in 1956, is still a major international classical music festival. The Jayuya Indian Festival takes place in November. Some performing groups, who help preserve local traditions, art, and music, receive sponsorship from Puerto Rico's Institute of Culture. An annual drama festival promotes the theatre in Puerto Rico.

### Facts in brief about Puerto Rico

**Capital:** San Juan.

**Government:** *U.S. Congress*—Resident commissioner, who votes only in committees. *Commonwealth legislature*—senators, 27; representatives, 53. *Local government*—78 municipalities.

**Area:** 9,103 km², including Culebra, Mona, and Vieques islands and 145 km² of inland water. *Greatest distances*—east-west, 179 km; north-south, 63 km. *Coastline*—501 km.

**Elevation:** *Highest*—Cerro de Punta, 1,338 m above sea level. *Lowest*—sea level along the coast.

**Population:** *1990 census*—3,522,037; density, 387 people per km²; distribution, 67 per cent urban, 33 per cent rural. *1980 census*—3,196,520.

**Chief products:** *Agriculture*—milk, poultry and eggs, beef cattle, sugar cane, coffee. *Fishing industry*—lobsters. *Manufacturing*—medicines, electrical machinery and equipment, processed foods, scientific instruments, nonelectrical machinery, clothing.

**Land and climate.** Puerto Rico is oblong in shape, covering an area of about 9,100 square kilometres. Puerto Rico is the smallest and most easterly of the islands that make up the Greater Antilles. It lies 80 kilometres east of Hispaniola, the second-largest of the Greater Antilles group. The largest of the other islands in the Commonwealth of Puerto Rico, in order of size, are Vieques, Mona, and Culebra.

Puerto Rico has four main land regions. *The Coastal Lowlands* border the coast on the north and the south. The northern lowlands are about 13 to 19 kilometres wide. Their climate is generally humid. The southern lowlands cover a narrower area and are drier. *The Coastal Valleys* extend inland from the coast on the east and the west. Most of the land in these valleys is used for growing sugar cane. *The Foothills* rise in two long east-west chains, just inland from the northern and southern coastal lowlands. Much of the area has jagged peaks and round basins. *The Central Mountains* run east-west across the south-central part of the island. The main range is the Cordillera Central. The highest peak in Puerto Rico, Cerro de Punta, rises 1,338 metres in the Cordillera Central.

**Climate.** Puerto Rico's pleasant climate makes the island a popular resort. Temperatures average about 23 °C in January and 27 °C in July. The drier sections of the southern coast average 94 centimetres of rain a year. Rainfall in the north averages 180 centimetres a year. Hurricanes may occur from June to November.

**Animals and plants.** Puerto Rico has a few types of nonpoisonous snakes, lizards, and iguanas. The *Paso Fino,* a type of horse, is bred in the island. The *coqui,* a tiny tree frog with a loud, distinctive call, is found only in Puerto Rico. Puerto Rican plants include breadfruit, sea grapes, poincianas, African tulips, ceibas, and star apples.

**Economy.** More than 1½ million tourists visit Puerto Rico every year. Most of them come from the United States mainland. The year-round balmy weather not only attracts many tourists, but also helps to make Puerto Rico a desirable location for industries.

Apart from tourism, the fastest-growing service industry in Puerto Rico is banking. The banking sector is worth an estimated U.S.$40 billion.

Manufacturing is of prime importance to Puerto Rico's economy. Factories employ about 17 per cent of the working population. They manufacture and process a great variety of products including chemicals, electrical machinery and equipment, food products, scientific instruments, nonelectrical machinery, and clothing. Other important manufactured products made in Puerto Rico include rubber and plastic goods; stone, clay, and glass wares; fabricated metals; printed materials; and leather and leather goods. Puerto Rico has five *centrales* (sugar mills) that produce raw sugar from sugar cane grown on the island. Molasses, rum, and beer are also produced.

Agriculture is of little importance economically. About 60 per cent of Puerto Rico's total land area is farmland. Much fertilizer must be used to enrich the fields, because the land has been worked hard for hundreds of years. Milk, poultry, and eggs are Puerto Rico's most valuable animal products. Farmers also raise beef cattle. Sugar cane and coffee are the leading crops in Puerto Rico. Bananas and *plantains* (starchy fruit similar to bananas) are Puerto Rico's most important commercial fruit. Other fruit grown commercially include avocados, coconuts, pineapples, and citrus fruit.

Puerto Rico has an annual catch of about 2 million kilograms of fish and shellfish. Lobster is Puerto Rico's most valuable catch.

Puerto Rico has about 12,400 kilometres of surfaced roads. These roads provide good transportation by car, bus, and lorry throughout the island. Puerto Rico's chief seaports are San Juan in the north, Ponce in the south, and Mayagüez in the west.

**History.** When Christopher Columbus first landed in Puerto Rico in November 1493 and claimed the island for Spain, he found a peace-loving people called the Arawak already living there. The Arawak probably had made their way to Puerto Rico from South America by way of the Lesser Antilles during the A.D. 600's. They

**The Coastal Lowlands** border Puerto Rico's coast on the north and the south. Farmland in the northern lowlands, near Arecibo, is shown on the left. Farmland covers more than half of Puerto Rico's total land area.

A narrow, shop-lined street in Old San Juan

called the island Borinquen. The Spaniards founded their initial settlement in Puerto Rico in 1508, under the governorship of Juan Ponce de León. The Spanish settlers forced the Arawak to search for gold and provide food for them. When the Arawak rebelled, the Spaniards overcame them with superior weapons. Overwork and disease killed most of the Arawak by the mid-1500's.

Over the next 100 years, the Spaniards were disappointed by the small amount of gold they found. They turned instead to agriculture and brought in African slaves to help work on sugar cane plantations.

The Spaniards kept their foothold in Puerto Rico because it was important as a supply base and could offer protection for their seaborne expeditions into North America. The colonists therefore fortified the capital, San Juan. Puerto Rico suffered attacks from the Carib, a warlike people from the neighbouring islands, and from French, English, and Dutch ships.

Spain ruled Puerto Rico for nearly 400 years. In 1879, slavery was abolished. By 1897, Spain decided to give Puerto Rico a large measure of autonomy. In 1898, following the short Spanish-American War, Spain surrendered Puerto Rico to the United States. Puerto Ricans were given U.S. citizenship in 1917.

In the early 1940's, Puerto Rican leaders began an economic programme to improve living conditions in the island. The programme became known as Operation Bootstrap. Large farms were broken up, and land was redistributed among farm workers. Improvements in education reduced illiteracy, and steps were taken to improve housing.

In 1946, U.S. President Harry S. Truman appointed Jesús Toribio Piñero as the first island-born governor of Puerto Rico. In 1947, the U.S. Congress granted Puerto Ricans the right to choose their own governor. In 1948, they elected to the post Luis Muñoz Marín, leader of the Popular Democratic Party (PPD). Marín's party favoured a commonwealth status for Puerto Rico, maintaining its links with the United States. In 1950, the U.S. Congress passed a law allowing Puerto Rico to write its own constitution. By 1952, a Puerto Rican convention had drafted the constitution, and it had been approved by both the Puerto Rican people and the U.S. Congress. It was adopted on July 25, 1952. Under it, Puerto Rico became a self-governing commonwealth.

In the 1950's and 1960's, the improvements brought by Operation Bootstrap became noticeable. Many industries were attracted to Puerto Rico because under its constitution it was free from paying federal tax. However, increases in income, tourism, and trade went hand in hand with soaring unemployment. Many Puerto Ricans migrated to the United States mainland, especially to New York. Few could speak English and found it just as hard to find work as they had on the island. Immigration ghettos bred resentment and violent crime. In Puerto Rico itself, the economy suffered badly during the early 1980's and early 1990's, when the U.S. economy hit recession. In 1989, Hurricane Hugo also severely damaged the island's economy.

In 1967, Puerto Ricans voted to retain their United States Commonwealth status. Since 1968, political power has been held either by the PPD or by the New Progressive Party (PPN). In 1992, Pedro Rossello of the PPN won the election.

See also **Ponce de León, Juan; San Juan; Spanish-American War.**

**Puff adder.** See **Adder; Snake** (picture: In rectilinear movement).

**Puffball** is a fungus that produces a ball-shaped fruit with spores completely enclosed. Many puffballs have white flesh. They are edible until the flesh begins to become coloured, or corky in texture. As puffballs mature, the inside becomes a mass of powdery spores, yellowish or purplish or olive-coloured. Sometimes an opening, or crater, develops in the top of a puffball. Clouds of tiny spores that look like puffs of smoke may come out through the opening when the fruit is touched or squeezed. For this reason, one kind of puffball is called the *devil's snuffbox.* Another kind, the giant puffball, can grow to 30 centimetres across.

Puffball

**Scientific classification.** Puffballs belong to the puffball family, Lycoperdaceae. The devil's snuffbox is *Lycoperdon perlatum.* The giant puffball is *Langermannia gigantea.*

**Puffer** is a type of fish that can inflate its body like a balloon. Puffers normally measure from 5 to nearly 60 centimetres in length. They can greatly expand their stomachs and take on the shape of a ball by rapidly swallowing water or air. Puffers often inflate their bodies to protect themselves from enemies.

There are about 120 kinds of puffers. They have greatly modified scales and many have smooth, leathery skin. Some have prickles on their underside that appear only when the fish inflates its body. Certain small puffers have a long, narrow snout. All puffers have strong upper and lower teeth that form a beak. Puffers use their teeth to tear coral or crush the shells of various sea animals. They feed mainly on shellfish, such as clams, crabs, and shrimp.

Most puffers live in warm seas. A few varieties are found in rivers and other fresh water. Some puffers can be eaten, but most are poisonous. In Japan, puffer is

**The puffer,** *above,* becomes twice its normal size and floats on the surface of the water when it inflates its stomach, *below.*

called *fugu* and considered a rare and tasty dish. Some puffers do well in home aquariums.

**Scientific classification.** Puffers belong to the family Tetraodontidae.

**Puffin,** also called *sea parrot,* is a bird that lives in the Arctic waters of the Atlantic and Pacific oceans. It has a thick body, a large head, and a high, flattened bill. During the breeding season, coloured growths form on the male puffin's beak. On the Atlantic and horned puffins, the breast and underparts are white. The wings, tail, and forepart of the neck of these types of puffins are blackish, and the sides of the head and throat are white. The tufted puffin of the North Pacific, and Bering Sea, is dark underneath, with a white streaked plume on the side of the head. Puffins feed chiefly on fish. They are expert swimmers and divers, and they come to land mainly in June and July, during the breeding season. Puffins make their nests in large colonies on rocky coasts and on islands. One white egg is laid in a burrow or crevice in the rocks. The chick remains in the burrow for 7 to 8 weeks after hatching. The chick then emerges and learns how to feed on its own.

**Horned puffins** spend the summer on the Pacific coasts of Alaska and Russia, where they rear their young. The rest of the year, they live in the North Pacific Ocean.

**Scientific classification.** Puffins belong to the auk family, Alcidae. The Atlantic puffin is *Fratercula arctica;* the horned puffin, *F. corniculata,* and the tufted, *Lunda cirrhata.*

**Pug** is a small dog with a short nose and a tail that curls tightly over its back. It is the largest of the toy-size dogs and weighs 6 to 8 kilograms. It stands about 25 to 30 centimetres high. Its face is deeply wrinkled. Its hair is short and smooth. The pug originally came from China.

See also **Dog** (picture: Toy dogs); **Toy dog.**

**Puget, Peter** (1762?-1822), a British naval officer and explorer, played an important part in the exploration of the north Pacific Coast of North America. Puget Sound, in the U.S. state of Washington, Cape Puget in Alaska, and Puget Island in the Columbia River were named after him. From 1791 to 1795, Puget sailed as a lieutenant with Captain George Vancouver on a four-year voyage around the world.

In 1792, they became the first Europeans to reach the sound, or arm, of the Pacific Ocean that Vancouver named after Puget. Puget explored the sound, surveyed the Yakutat Bay area on the southern Alaska coast, and helped explore Cook Inlet and Prince William Sound, farther up the coast. See also **Vancouver, George.**

**Puget Sound** is a large, irregular inlet in the northwest corner of the U.S. state of Washington. Puget Sound is a leading American shipping centre. The ports of Seattle, Tacoma, Bremerton, Olympia, and Everett stand on its banks. The sound is 130 kilometres long, and covers an area of about 5,200 square kilometres. The largest ships can steam into any part of the sound, as its depth ranges from about 55 to 280 metres.

The Strait of Juan de Fuca links Puget Sound and the Pacific Ocean. From the meeting point of this strait and the Strait of Georgia, Puget Sound extends southward for about 55 kilometres before it divides into two main branches—Admiralty Inlet and the Hood Canal. The Lake Washington Ship Canal extends from Puget Sound to Lake Washington at Seattle.

Most of the sound's shores are high and wooded. The sound has many islands. Whidbey Island, about 65 kilo-


**Location of Puget Sound**

metres long, is one of the largest U.S. islands.

The sound is noted for the fisheries and timber mills along its shores. Fish packing and canning are among the most important industries of the region. Puget Sound is the centre of Washington's timber industry.

See also **Puget, Peter.**

**Pugh, Clifton** (1924-1990), an Australian painter, won the Archibald Prize for portrait painting at the Art Gallery of New South Wales, Australia, in 1965, 1971, and 1972. He became known for his love of the Australian bush and became an active conservationist in the 1960's.

Clifton Pugh

Clifton Ernest Pugh was born in Melbourne. He developed his natural flair for formal portrait painting at the National Gallery of Victoria under Sir William Dargie.

Pugh first caught the attention of the public with his paintings of Australian animals, which he exhibited at the Victorian Artists Society in 1965. The animals were dramatically presented in the post-impressionist manner, integrated with the sombre bush environment. His later work evolved from his travels in outlying bush country and central Australia.

**Pugin** was the family name of three British architects who had a great influence upon the revival of Gothic architecture in the 1800's.

**Auguste Charles Pugin** (1762-1832) maintained a training school for architects. In 1824, he helped John Nash to remodel Windsor Castle. He was born at Soissons, in France.

**Augustus Welby Northmore Pugin** (1812-1852), the son of Auguste Charles, designed many of the decorations for the Houses of Parliament, London; many Roman Catholic churches; and the gateway to Magdalen College, Oxford. He was born in London.

**Edward Welby Pugin** (1834-1875), son of Augustus Welby, designed many churches, including St. Colman's Catholic Cathedral at Cobh, in southern Ireland. He was born in Salisbury.

**Pukeko** is a colourful New Zealand bird that lives in swamps, lake shores, and poorly drained farmland. Unlike their relative, the takahe, the pukeko can fly. It can also run fast and can swim well for short distances. It grows to a length of about 50 centimetres. The plumage is mainly indigo blue. The head and wings are black. The pukeko eats grasses, berries, and seeds.

**Scientific classification.** The pukeko belongs to the family Rallidae. It is *Porphyrio melanotus.*

**Pulaski, Casimir** (1747?-1779), a Polish nobleman and soldier, won fame for his role with the Continental Army in the American Revolution (1775-1783). He sailed to America in 1777 to offer his services to General George Washington. Pulaski was Washington's aide-de-camp at the Battle of Brandywine in September 1777. At Washington's urging, Congress made Pulaski a brigadier general. Pulaski, an expert cavalryman, organized a corps of cavalrymen called Pulaski's Legion. The group performed valiantly in the South. It participated in the siege of Savannah, Georgia, where Pulaski was wounded on Oct. 9, 1779. He died two days later.

Casimir Pulaski

Before going to America, Pulaski led an unsuccessful revolt of Polish forces against Russia, which controlled Poland at that time. He learned of the American cause in France from Benjamin Franklin, who encouraged him to travel to America.

Pulaski was born in the province of Podolia, Poland, now part of Ukraine. By an act of the U.S. Congress, October 11 is observed as Pulaski Day.

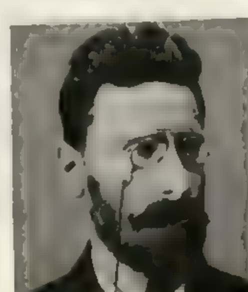
**Puli** is a medium-sized sheepdog originally bred in Hungary. The puli's coat is black, rust-coloured and black, white, or grey and becomes tangled into ropelike cords if allowed to grow naturally. The dog is intelligent and fun-loving. It makes an excellent pet and watchdog. The puli stands about 40 centimetres tall at the shoulder and weighs about 15 kilograms.

See also **Dog** (picture: Some breeds of dogs).

**Pulitzer, Joseph** (1847-1911), was a Hungarian immigrant who became one of the greatest American newspaper publishers in history. He established the Pulitzer Prizes for achievements in journalism, literature, music, and art.

Pulitzer was born in Mako, Hungary, on April 10, 1847. His family moved to Budapest when he was young. He left home at 17 in search of military adventure, but the armed forces of Austria, France, and Great Britain rejected him because of his poor health and bad eyesight. A United States recruiter enlisted Pulitzer in Germany to fight with the Union Army in the American Civil War. After brief service in the war, he settled in St. Louis, Missouri, became a U.S. citizen, and worked as a labourer.

**His career.** In 1868, Pulitzer became a reporter on a German-language newspaper in St. Louis. Within four years, he became managing editor and part owner of the paper. He won a seat in the Missouri House of Representatives in 1869. Pulitzer became a leader among the people of German descent in St. Louis, and helped Horace Greeley in his campaign for the presidency in 1872. However, three years later, Pulitzer became a Democrat and sold his interest in the newspaper, which was Republican.



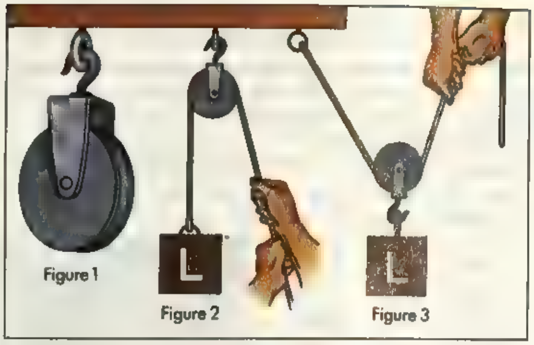
Joseph Pulitzer

In 1876 and 1877, Pulitzer served as a correspondent in Washington, D.C., for the *New York Sun.* He bought the *St. Louis Dispatch* and *Evening Post,* in 1878, and combined them into the *St. Louis PostDispatch.* Within four years, the *St. Louis Post-Dispatch* had made him a fortune.

In 1883, Pulitzer bought the *New York World,* a financially troubled New York City paper. He soon transformed the *World* into a vigorous, crusading newspaper with the largest circulation in the nation, 250,000 in 1887. This paper was one of the first to use the colour comics and sensationalism that gave rise to "yellow journalism" (see **Journalism** [The age of sensationalism]).

Pulitzer was almost totally blind after 1887, and also extremely sensitive to noise. From then until his death, he directed the *World* and the *Post-Dispatch* from his home with the help of secretaries.

**His bequests.** Pulitzer left 2 million U.S. dollars to establish a graduate school of journalism at Columbia University, New York City. The Pulitzer Prizes were created with part of this money. He left 500,000 U.S. dollars each to the New York Philharmonic Society and to the Metropolitan Museum of Art. Pulitzer's will also provided that the *World* should never be sold. But a court permitted the sale of the newspaper in 1931 because of financial losses. The family kept the *Post-Dispatch.*




**A simple pulley** is shown in Figure 1. Figure 2 shows a fixed pulley that merely changes the direction of the force applied to the load (L). It has a mechanical advantage of 1. Figure 3 is a movable pulley from which the load is suspended.

**Pulley** is a wheel over which a rope or belt is passed for the purpose of transmitting energy and doing work. When the pulley carries a rope, its rim is grooved. However, if the pulley is to carry a belt, the rim is barrel-shaped and the belt rides on the highest part of the rim.

The simplest pulley is a grooved wheel on a fixed axle. A rope passing over this wheel is tied to the load to be lifted, and a force is applied to the other end of the rope. This pulley gives no mechanical advantage of lift, but changes the direction of the force applied to the load. This is important when the space directly under the load is hard to get at, as when the load is in a boat, a pit, or where footing is slippery.

When the pulley is to carry a continuous turning motion, the two ends of the rope or belt are laced together. A second pulley, which is connected to the source of energy, transmits a steady rotation to the first pulley. If the driver pulley and the driven pulley are of the same size, the only advantage is a choice of directions from which the energy may come. If the pulleys are of different sizes, an advantage of either speed or force may be obtained. Crossing the rope or belt that runs between the two pulleys reverses the direction of turn of the driven pulley.

The second basic type of pulley is a *movable pulley.* The load is attached to the axle of this pulley. One end of the rope that passes through the pulley is attached to a fixed support above the load. A pull is applied to the free end of the rope in the same direction the load is to move. The mechanical advantage of a movable pulley is 2. This means that the pull applied to the free end of the rope need be only half the weight of the load. The rope attached to the fixed support also carries half the weight of the load.

See also **Block and tackle; Machine.**

**Pullman, George Mortimer** (1831-1897), was an American inventor and businessman. Pullman is remembered chiefly in connection with the railway sleeping car, which he improved and brought into general use in the United States.

Pullman was born in Brocton, New York, U.S.A. He learned the trade of a cabinetmaker and then worked as a construction contractor. Moving to Chicago in 1855, he became interested in improving the crude railway sleeping cars then in operation. In 1858, he remodelled two coaches into sleeping cars for the Chicago & Alton Railroad. Pullman and his friend, Ben Field, then designed a larger and more elaborate sleeping car, which they named *Pioneer.* It entered service in 1865, and was used in Abraham Lincoln's funeral train from Washington, D.C., to Springfield, Illinois. The car could be converted from day to night use by folding down the upper berths, making the seats into lower berths, and separating the berths by curtains.

Pullman introduced a dining car that had its own kitchen in 1868. He also introduced the parlour, or saloon, car in 1875 and the vestibule for direct connection between cars in 1887. Pullman organized the Pullman Palace Car Company (later called the Pullman Company) in 1867. This firm built, staffed, and operated sleeping cars on all major railways. By 1890, Pullman possessed a virtual monopoly on the sleeping-car business in the United States. His headquarters were in Pullman, Illinois, a town built and owned by the Pullman Company. The town became part of Chicago in 1889.

**Pullman sleeping car.** See **Pullman, George Mortimer.**

**Pulp.** See **Paper** (How paper is made; diagram); **Forest products** (Paper and paperboard).

**Pulp magazine.** See **Science fiction** (The 1900's).

**Pulpwood.** See **Paper** (How paper is made).

**Pulsar** is an object in space that sends out regular bursts of electromagnetic radiation, mainly in the form of radio waves. Pulsars received their name from these highly regular pulses.

Scientists believe pulsars are rapidly spinning *neutron stars,* dense stars composed primarily of tightly packed neutrons (see **Neutron star**). An extremely powerful magnetic field surrounds the neutron star and rotates with it. This rapidly rotating magnetic field produces a strong electric field that rips electrons and protons from the star's surface. As these particles flow from the star, they emit energy in the form of a narrow beam of radio waves. The beam rotates much like a searchlight on a lighthouse. Using a giant radio telescope, an astronomer can detect a pulse of radio waves each time the pulsar rotates and the beam sweeps past the earth.

On average, pulsars spin at the rate of twice a second. All pulsars eventually lose energy and slow down. They do so in such a gradual and predictable manner that their pulses can be used to measure time.

The strong gravity of a pulsar can capture gases from a nearby companion star. These gases crash into the pulsar, creating hot spots that send out beams of X rays. X rays are a form of electromagnetic radiation with much shorter wavelengths than radio waves.

Some pulsars gain momentum and rotate faster as they capture gases from companion stars. These pulsars, called *millisecond pulsars,* rotate hundreds of times per second. Scientists believe many millisecond pulsars occur in high concentrations of stars known as *globular clusters.*

Pulsars were discovered in 1967 by British astronomers Antony Hewish and Jocelyn Bell (now Jocelyn Bell Burnell) at Cambridge University. Today, scientists study pulsars to learn more about the motions at the centre of globular clusters, the matter between stars in the Milky Way, and other topics. They continue to investigate how pulsars turn their enormous rotational energy into radio beams.

See also **Neutron star; Star** (picture: The Crab Nebula); **Cosmic rays.**

**Pulse** is caused by a stretching of the arteries that takes place after each heartbeat. It can be felt by placing the fingers on the wrist above the thumb, at a point over the *radial artery.* The pulse also can be felt by touching the temples where the *temporal artery* is located, and at other places on the body where an artery is near the surface.

Each heartbeat consists of a contraction of the muscles of the heart that propels the blood into the arterial system, followed by a period of relaxation during which the heart refills. As the heart contracts, the blood is pumped into the *aorta* and *pulmonary arteries.* The aorta, the largest artery in the body, carries the blood aerated in the lungs from the left side of the heart to the rest of the body. As the blood rushes into the aorta its elastic walls are stretched and it expands to make room for the blood. As the blood moves on to enter the arteries that branch off from the aorta, the walls relax and it contracts to normal size. The walls of these arteries and of their branches also expand and contract as the blood passes through them. The expansion of these arteries causes the pulsation known as the *pulse.*

The pulse rate of children is faster and that of old people often slower than that of an average healthy adult. While pulse rates between 50 and 85 per minute are considered within normal limits, the normal rate for an average man is about 72. The pulse of an average woman is a little faster—76 to 80 per minute. The pulse rate of a newborn child may be as high as 140 per minute. The normal rate for a seven-year-old child is about 90 per minute. Slower pulse rates of from 50 to 65 per minute are not unusual in elderly people. But regardless of a person's age, the pulse and heart rhythm should be regular.

A doctor feels a patient's pulse to find out if the heart is beating normally. If the pulse is too fast or too slow or irregular, the doctor examines the patient to diagnose the cause of the abnormal pulse.

See also **Artery; Heart.**

**Puma.** See **Mountain lion.**

**Pumice** is a greyish-white natural glass with many tiny holes. It is a valuable scouring, scrubbing, and polishing material in both powdered form and as pumice stone. Pumice forms when lava from a volcano flows onto the earth's surface or erupts violently into the air. The hot, gas-filled lava then cools quickly to form glass. Many tiny holes remain after the volcanic gases escape from the cooling lava. Pumice floats on water because it contains many air bubbles.

**Pump** is a device that moves or compresses liquids and gases. Pumps are used in a variety of machines and other devices, including home heating systems, refrigerators, oil wells and water wells, and turbojet and car engines. The *fluids* (gases or liquids) moved by pumps range from air for inflating bicycle tyres to liquid sodium and liquid potassium for cooling nuclear reactors. Most pumps are made of steel, but some are made of glass or plastic. Gas pumps are also called *compressors, fans,* or *blowers.*

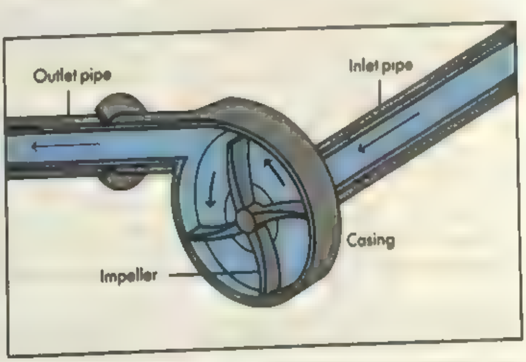
There are two major types of pumps—*dynamic pumps* and *positive displacement pumps.* Dynamic pumps maintain a steady flow of fluid. Positive displacement pumps, on the other hand, trap individual portions of fluid that are in an enclosed area before moving them along.

### Dynamic pumps

**Centrifugal pumps** consist of a motor-driven propellerlike device, called an *impeller,* which is contained within a circular housing. The impeller is a wheel of curved blades that rotates on an axis. Before most centrifugal pumps can start pumping liquid, they must be *primed* (filled with liquid). As the impeller rotates, it creates suction that draws a continuous flow of fluid through an inlet pipe. Fluid enters the pump at the centre of the impeller and travels out along the blades due to *centrifugal* (outward) force. The curved ends of the blades sweep the fluid to an outlet port.

Centrifugal pumps are inexpensive and can handle large amounts of fluid. They are widely used in chemical processing plants and oil refineries.

**Axial-flow pumps** have a motor-driven rotor that directs fluid along a path parallel to its axis. The fluid thus travels in a relatively straight path from the inlet pipe through the pump to the outlet pipe.




**A centrifugal pump** consists of a rotating device called an *impeller* within a circular casing. Fluid enters the pump near the centre of the impeller, which sweeps it to an outlet pipe.

Axial-flow pumps are most often used as compressors in turbojet engines. Centrifugal pumps are also used for this purpose, but axial-flow pumps are more efficient. Axial-flow compressors consist of alternating rows of rotors and stationary blades. The blades and rotors produce a pressure rise in the air as it moves through the axial-flow compressor. Air then leaves the compressor under high pressure. See **Jet propulsion** (Turbojet).

**Jet pumps** get their name from the way they move fluid. They operate on the principle that a high-velocity fluid will carry along any other fluid it passes through. Most jet pumps send a jet of steam or water through the fluid that needs to be moved. The jet carries the fluid with it directly into the outlet pipe and, at the same time, creates a vacuum that draws more fluid into the pump. The amount of fluid carried out of most jet pumps is several times the amount in the jet itself.

Jet pumps can be used to raise water from wells deeper than 60 metres. In such cases, a centrifugal pump at ground level supplies water for a jet at the bottom of the well. The jet carries well water with it back up to ground level. Jet pumps are also used in *high vacuum diffusion pumps* to create a vacuum in an enclosed area. In high vacuum diffusion pumps, a high-velocity jet of mercury or oil vapour is sent into the enclosed area. The vapour molecules collide with the molecules of air and force them out the outlet port.

**Electromagnetic pumps** are used chiefly to move liquid sodium and liquid potassium, which serve as coolants in nuclear reactors. These pumps consist of electrical conductors and magnetized pipes. The conductors send current through the fluid, which thereby becomes an electromagnet. The fluid is then moved by the magnetic attraction and *repulsion* (pushing away) between the fluid's magnetic field and that of the pipes. The fluid is therefore moved in an electromagnetic pump in much the same way as an armature is moved in an electric motor (see **Electric motor**).

### Positive displacement pumps

**Rotary pumps** are the most widely used positive displacement pumps. They are often used to pump such *viscous* (sticky) liquids as motor oil, syrup, and paint. There are three main types of rotary pumps. These types are: (1) gear pumps, (2) lobe pumps, and (3) sliding vane pumps.

*Gear pumps* consist of two gears that rotate against the walls of a circular housing. The inlet and outlet ports are at opposite sides of the housing, on line with the point where the teeth of the gears are fitted together. Fluid that enters the pump is trapped by the rotating gear teeth, which sweep the fluid along the pump wall to the outlet port.

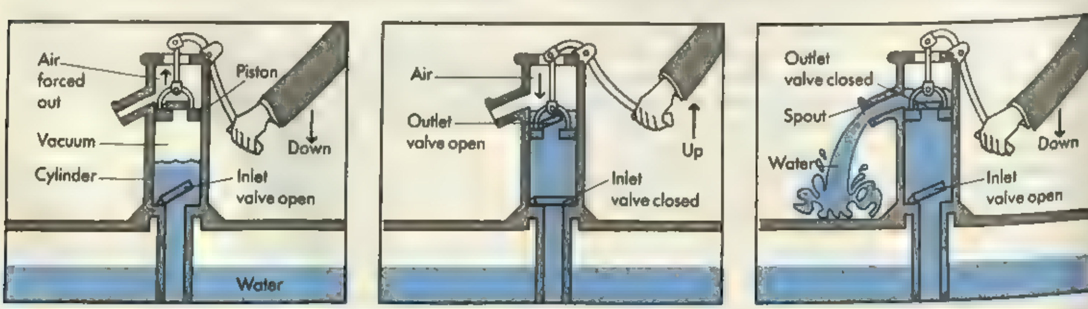
*Lobe pumps* operate in a manner similar to gear pumps. However, instead of gears, lobe pumps are equipped with impellers that have *lobes* (rounded projections) fitted together. Lobe pumps can discharge large amounts of fluid at low pressure.

*Sliding vane pumps* consist of a slotted impeller mounted off-centre in a circular housing. Sliding *vanes* (blades) move in and out of the slots. As the vanes rotate by the inlet port, they sweep up fluid and trap it against the pump wall. The distance between the impeller and the pump wall narrows near the outlet port. As the fluid is carried around to this port, the vanes are pushed in and the fluid is compressed. The pressurized fluid then rushes out the outlet port.

**Reciprocating pumps** consist of a piston that moves back and forth within a cylinder. One end of the cylinder has an opening through which the *connecting rod* of the piston passes. The other end of the cylinder, called the *closed end,* has an inlet valve or an outlet valve, or both, depending on the type of pump. In some reciprocating pumps, the inlet valve or the outlet valve is on the piston. Common reciprocating pumps include lift pumps, force pumps, and bicycle tyre pumps.

*Lift pumps* draw water from wells. In a lift pump, the inlet valve is at the closed end of the cylinder and the outlet valve is on the piston. As the piston is raised, water is drawn up through the inlet valve. As the piston moves down, the inlet valve closes, forcing water through the outlet valve and up above the piston. As the piston is raised again, the outlet valve closes and the water is lifted to an opening, where it leaves the pump. At the same time, more water is drawn through the inlet valve. It is theoretically possible for a lift pump to raise water in a well almost 10 metres. However, because of leakage and resistance, a lift pump cannot raise water that is deeper than about 7.5 metres.

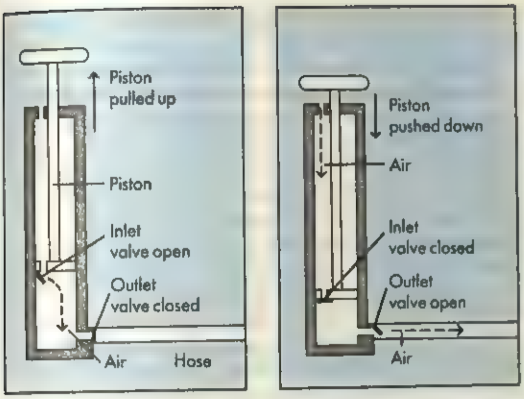
**How a lift pump works** Lift pumps are used to draw water from some wells. The outlet valve is on a piston, which moves up and down in the pump's cylinder. The inlet valve is at the closed end of the cylinder.




**When the handle is pushed down,** the piston rises and forces out air. Water enters the cylinder to replace the air.

**Pulling up** on the handle lowers the piston through the water. Force closes the inlet valve and opens the outlet valve.

**Pushing down** on the handle raises the piston, and the water above the piston pours out the spout.




**A bicycle tyre pump** has a piston that moves up and down. When the piston is raised, the air above it flows to the bottom of the pump. When it moves down, air is forced out the hose.

*Force pumps* are similar to lift pumps. However, in force pumps, both the inlet valve and the outlet valve are at the closed end of the cylinder. As the piston moves away from the closed end, fluid enters the cylinder. When the piston moves toward the closed end, the fluid is forced out the outlet valve.

*Bicycle tyre pumps* differ in the number and location of the valves they have and in the way air enters the cylinder. Some simple bicycle tyre pumps have the inlet valve on the piston and the outlet valve at the closed end of the cylinder. Air enters the pump near the point where the connecting rod passes through the cylinder. As the rod is pulled out, air passes through the piston and fills the areas between the piston and the outlet valve. As the rod is pushed in, the inlet valve closes and the piston forces air through the outlet valve.

### History

Pumping devices have been an important means of moving fluids for thousands of years. The ancient Egyptians used water wheels with buckets mounted on them to move water for irrigation. The buckets scooped water from wells and streams and deposited it in ditches that carried it to fields. In the 200's B.C., Ctesibius, a Greek inventor, made a reciprocating pump for pumping water. About the same time, Archimedes, a Greek mathematician, invented a screw pump that was made up of a screw rotating in a cylinder (see **Archimedean screw**). This type of pump was used to drain and to irrigate the Nile Valley.

True centrifugal pumps were not developed until the late 1600's, when Denis Papin, a French-born inventor, made one with straight vanes. The British inventor John Appold introduced a curved-vane centrifugal pump in 1851. Axial-flow compressors were first used on turbojet engines in the 1940's.

See also **Construction equipment** (Pumping machines); **Milking machine; Well.**

**Pumpkin** is a vegetable related to marrows. Pumpkin plants produce round or oval fruits, also called *pumpkins,* that have hard shells and coarse, stringy pulp. A central cavity within the fruit holds the seeds. Most pumpkins weigh from about 7 to 14 kilograms, but some weigh as much as 90 kilograms. The majority of pumpkins are orange, but many are white, yellow, or other colours.

Pumpkins are a rich source of vitamin A and potassium. People cook pumpkins in various ways. Farmers use pumpkins as livestock feed. Pumpkin seeds, which provide protein and iron, are a popular snack. Pumpkins are often hollowed out and carved into lanterns for use as decorations on Halloween.

Pumpkin plants have large, prickly leaves and produce male and female flowers. Only the male pumpkin blossoms have pollen that is transferred by bees to the female flowers. Pollinated female blossoms develop into pumpkins. But each female flower opens for pollination for only one day. In addition, most pumpkin blossoms are male. As a result, few flowers actually produce pumpkins.

**Pumpkins** have a hard outer shell and coarse, stringy pulp. People cook pumpkins in a variety of ways. Pumpkin seeds are a popular snack.

Pumpkins grow on vines and bushes. Those on vines are planted in mounds about 3.5 metres apart. Bush varieties are spaced closer together. Pumpkins thrive in slightly acid soil, and most mature about four months after the seeds are planted. Ripe, well-developed pumpkins can be stored at 4° to 10° C for several months.

Pumpkin plants need careful cultivation to produce healthy fruit. For example, pumpkin growers use pesticides or mosquito netting to prevent plant damage by insects.

Pumpkins probably originated in North America. Seeds from related plants dating back to 7000 to 5500 B.C. have been found in Mexico.

**Scientific classification.** Pumpkin plants belong to the gourd family, Cucurbitaceae. There are four species—*Cucurbita pepo, C. mixta, C. moschata,* and *C. maxima.*

See also **Squash.**

**Pun** is a humorous use of words that sound alike or nearly alike but have different meanings. For example, a rascally character in William Shakespeare's play *Henry V* says, "To England will I steal, and there I'll steal." A pun

also may be called a *play on words.* Because a pun condenses more than one meaning into one word, an author can use a pun to present several ideas in a single expression.

Some literary critics, particularly those of England during the 1700's, have called the pun "the lowest form of wit." However, many of the world's greatest writers have frequently used puns. For example, some of the most delightful passages in Shakespeare's early comedies are those in which characters indulge in punning contests. The Irish novelist James Joyce filled his novel *Finnegans Wake* (1939) with clever puns in several languages.

See also **Humour** (Puns).

**Punch and Judy** are the main characters in a type of comic puppet show popular in England. Punch is a hook-nosed hunchback who wears a traditional Italian costume. Judy is his wife. A typical Punch-and-Judy show has much rough, violent humour. In the show, Punch usually beats his child, quarrels with his wife, and kills her and sometimes other characters. Punch is brought to trial and sentenced to death, but escapes punishment through trickery.

**Punch and Judy** are popular puppet characters, especially in England. A typical Punch-and-Judy show is filled with violent comedy involving the quarrelsome Punch, his wife, and baby.

The character of Punch combines English, French, and Italian influences. His name came from Pulcinella, a popular character in Italian theatre during the 1600's. Punch-and-Judy puppet shows were introduced into England from continental Europe in 1662. By the 1800's, Punch-and-Judy shows were being presented in portable puppet theatres at fairs or on the streets throughout England.

See also **Puppet** (Hand puppets).

**Punctuation** is the use of certain marks in writing and printing to make the writer's meaning clear. The marks are also called *punctuation.*

Early writing and early printing had marks to show punctuation. But the signs were used according to the wish of the writer and to the marks that the printers had in their typecases. The ancient Greeks, for example, often used a semicolon in place of our modern question mark. Printing and punctuation improved rapidly during the 1400's and 1500's, especially in Italy. During this period, Aldus Manutius, an Italian printer and bookbinder, began to use the various marks more systematically. His work formed the basis of the punctuation used today in many written language systems.

Punctuation marks were used more frequently some years ago. Today, the trend is to use fewer and fewer marks, and in many places to use none at all. Writers today are less bound by the old rules.

**The full stop** (.) or *full point* is used at the end of a statement or command and after most abbreviations. In the United States, it is called the *period.* A full stop follows the sentence you have just read. Roman numerals (clxvi, CXXVI) are not followed by full stops. Full stops are not placed after page numbers in books, but they are placed after numbers in an outline or list.

**The question mark** (?) is used after a question. It is also called the *interrogation mark.* Every direct question should be followed by a question mark, as in *Do you understand this rule?* An indirect question does not end in a question mark. It is followed by a full stop, as in *Inspector Adams wondered who did it.* In Spanish writing and printing, an *inverted* (upside-down) question mark is used at the beginning of a direct question.

**The exclamation mark** (!) is used after a sentence that expresses strong feeling. *How cold it is!* Single words, phrases, or clauses of the same sort are followed by the exclamation mark. *Listen! You, over there! Trying to hide!* There are few occasions for using this mark, except in reporting speech. In Spanish, an inverted exclamation mark is used at the beginning of such expressions. See **Exclamation mark.**

**Quotation marks** (" ") enclose the exact words of a speaker. They are sometimes called *double quotation marks,* or *double quotes.* They enclose only the spoken words, as in *"I'm going to telephone Martha," said Bill,* and *"Do you think," Mother asked, "that she has come back from the beach?"*

Quotation marks are also used when material is taken word-for-word from another source. For example, an author uses quotation marks to set off text that originated with another author. When several paragraphs are quoted, quotation marks are usually placed at the beginning of every paragraph and at the end of the last quoted paragraph. Quotations within quotations are enclosed in single quotation marks, as in *"He answered, 'I will not,' when I asked him," she reported.*

Quotation marks may enclose titles of short written works, such as poems, lectures, sermons, and short stories. They also call attention to unusual uses of words, such as *a famous "first,"* and to identify nicknames, as in *Eric was called "The Red" because he had red hair.*

**The colon** (:) is frequently used after such expressions as *to the following:, as follows:.* Often the colon is followed by a list. *The chief national groups are as follows: English, French, Italian.*

**The semicolon** (;) is used in a compound sentence between two principal clauses that are not joined by a conjunction. *He struggled to land the bass; it flipped its tail as it vanished.* If principal clauses of a compound sentence contain commas, a semicolon is placed between the clauses even if a conjunction is used. *We rounded the corner yelling, swaying, and grinding; but having used the brakes too late, we skidded against the opposite wall.* The semicolon is also used instead of the comma after items in a series when these items are long or complicated.

**The dash** (—) is used to mark a sudden break in thought. *I considered her—it was a foolish opinion—too young to take care of herself.* Use dashes to set off emphatically any defining or enumerating matter in a sentence: *The work of two great English historians—Edward Gibbon and Thomas B. Macaulay—influenced him the most.*

**Parentheses** () enclose parts of the sentence that might easily have been omitted. The material between them is not connected grammatically with the rest of the sentence. *I explained to you* (*you don't remember when*) *why I cannot take a long trip.* The first mark is called an *opening parenthesis* and the second is called a *closing parenthesis.* The entire group of words enclosed by the marks is also called a *parenthesis.* See **Parenthesis**.

**Brackets** [ ] in quoted remarks enclose explanations not in the actual speech. *"I am a simple man."* [*Laughter*]. Directions in plays may be enclosed within parentheses or within brackets. *Duke Morris* [*Seriously*] *But I need money.* [*He turns away.*]

**The comma** (,) is the most commonly used punctuation mark. It has more uses than any other punctuation mark. Most of the principal ones are set down in the following examples.

It follows the words, phrases, or clauses in a series. *We ate crabs, lobster, shrimp, and fish.*

It follows items in addresses and dates. *He was born at 16 High Street, Tunbridge Wells, Kent, England, on November 24, 1911.*

It is placed around certain conjunctions, adverbs, and phrases, such as *now, however, nevertheless, for instance,* when it indicates a break in the construction. *Try, for instance, to borrow money without giving security.*

It is used after words, phrases, and clauses at the beginning of sentences unless there is a close connection. *If you perform that experiment again, I shall help you.*

It is used between the principal clauses of a compound sentence unless the sentence is short. *We stood terrified by the swollen stream, but one of us discovered a safe bridge along a huge fallen tree.*

It separates nonrestrictive subordinate clauses from the rest of the sentence. *The listening lad, who had been intently silent, suddenly let out a bloodcurdling yell.*

It sets off a word or phrase that explains some term. The second term is said to be an *appositive* of the first. *Radar, an electronic device, is of value in warfare.*

It sets off words like *well, yes, no,* and all nouns of address. *Yes, we saw the eclipse. Mr. Emerson, may I speak with Jane?*

It sets off quotations, especially in conversation. *"May I," he began shyly, "have the next dance?" "Surely," she answered.*

It is often used to avoid misunderstanding and to make the meaning clearer. *Some weeks before she arrived from Canada* is not clear. *Some weeks before, she arrived from Canada* is clear.

**The hyphen** (-) is most commonly used to link compound words, such as *twenty-three, Anglo-American,* and *forget-me-not.* It is also used at the end of a line when a word is broken into syllables and part of the word is put on the next line, as in *atti-tude, di-vision.*

**The apostrophe** (') is used in the place of omitted letters in contractions, as in *can't, she'll, they're.* It also substitutes for omitted letters in words used in poetry, as in *th', ev'ry,* and *'tis.* The apostrophe is also used to show the possessive case, as in *the student's book, the birds' song, the children's room.*

**Pune** (pop. 1,203,351), formerly called *Poona,* is a city in western India. It is an important political, military, and educational centre. It lies about 190 kilometres southeast of Bombay, in the state of Maharashtra. For location, see **India** (political map).

Pune is 555 metres above sea level. Parwatee Hill and Lion Fort overlook the city. The Mula and Mutha rivers are the city's main sources of water.

Important landmarks in the city include the University of Poona and the Bhandarkar Oriental Research Institute. Pune is also an army training centre. Railway and bus services connect it with cities in northern and southern India.

Pune is referred to in an inscription dating from the 700's. It first became important in the 1300's, when Muslim rulers fortified it with a mud wall. It was the private estate of the heroic Maratha ruler Shivaji, who threw off Muslim control of his kingdom. Pune became the Maratha capital. In the 1700's, under the Peshwas, it grew rapidly. The British took it over in 1817.

**Punic Wars** were three struggles between ancient Rome and Carthage. Rome won all three wars. The victories made Rome the supreme power of the Western Mediterranean, and helped Rome gain control of the entire Mediterranean world. *Punic,* the Latin word for *Phoenician,* is used for the wars because Carthage had been founded by the Phoenicians.

**The First Punic War** (264-241 B.C.) began when Rome intervened to prevent Carthage and Syracuse, a city on the island of Sicily, from controlling the Strait of Messina. The strait lay between Sicily and Italy. Rome became a naval power to meet Carthage on equal terms. Both sides lost several fleets and many men. The war was decided when Rome conquered Sicily and won a final naval battle there.

**The Second Punic War** (218-201 B.C.) developed from the first war and was caused in part by territorial rivalry in Spain between Rome and Carthage. Hannibal, a great Carthaginian general, crossed the Alps and invaded Italy (see **Hannibal**). The Romans finally defeated him in 202 B.C. Carthage then paid Rome a large sum and gave up Spain.

**The Third Punic War** (149-146 B.C.) resulted when Carthage rebelled against the restrictions of the Roman peace treaty of 201 B.C. Carthage was completely destroyed in this war.

Rome won the Punic Wars because it had better resources and more soldiers. Carthage was richer in the beginning, but it had to rely on *mercenaries* (hired troops). Hannibal had proved that mercenaries could fight well, but there were never enough of them.

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Army (Famous land battles [Metaurus; Zama])
Carthage
Hamilcar Barca
Regulus, Marcus Atilius
Rome, Ancient (Expansion overseas)
Scipio, Publius Cornelius

**Punishment.** See **Capital punishment; Crime; Penal colony; Prison; Reformatory; Sentence** (in law).

**Punjab** region occupies a vast plain in southern Asia. It lies partly in northern India and partly in northeastern Pakistan. The Punjab region has an area of about 700,000 square kilometres. The region includes the states of Punjab and Haryana in India and the province of Punjab in Pakistan.

The part of the Punjab lying within Pakistan is an agricultural area. It is the chief wheat-producing region of South Asia. Farmers in this area also grow citrus fruit, cotton, dates, mangoes, maize, millet, oilseeds, pomegranates, rice, and sugar cane. The region, hot in summer and mild in winter, experiences little rain in the south. Further north, the seasonal rainfall increases, rising to 120 centimetres in the foothills of the Himalaya.

About 47 million people live in the Pakistani province of Punjab. Most of them are Muslims. The provincial capital is Lahore. Punjab province also contains the city of Islamabad, the national capital of Pakistan. Lahore is a historic city with many beautiful buildings put up in the time of the Mughal emperor Shah Jahan. It is the site of the University of the Punjab and is a very important centre of textile manufacture and rubber, iron, and steel production. It also produces fine gold and silver handcrafted objects. Islamabad is a modern city built mainly in the 1960's, and is a centre of government administration and business. The nearby ancient city of Rawalpindi served as Pakistan's capital from 1959 to 1969, while Islamabad was being built.

The Punjab region takes its name from two Persian words meaning "Five rivers." These rivers are the Jhelum, Chenab, Ravi, Beas, and Sutlej. All are tributaries of the Indus, and the region contains sites associated with the ancient Indus Valley civilization, which flourished around 2000 B.C. Harappa, a major centre of this civilization, lies on the Sutlej River within the Pakistani section of the Punjab. Greeks, Scythians, and Muslims were among the many peoples who passed through and sometimes ruled over this region. The Punjab was also part of several native Indian empires including those of the Maurya, Gupta, and Vardhana.

From the 1100's, the Punjab was a part of the Delhi Sultanate, a series of Islamic rulers who came originally from Turkey and Afghanistan. Later, the Punjab became part of the Mughal Empire. From the 1500's, the region became the home of the Sikh religion.

In 1849, the British took control of the Punjab and later made it a province. In 1947, the Punjab was divided between the new nations of India and Pakistan. Hundreds of thousands of refugees died in riots as Hindus fled from the Muslim province within Pakistan and followers of Islam fled from the Indian state.

See also **Haryana; Punjab** (state).

**Punjab** is a state in northern India. It is the home of more than 80 per cent of India's 14 million Sikhs (see **Sikhism**). Punjab is the most prosperous state in India. Incomes are 78 per cent above the national average, and nearly every village has electricity. The soil is fertile and well watered. At the time of India's independence in 1947, the Punjab region was divided between India and Pakistan.

Punjab is the leading wheat-growing region of India. Crop yields are consistently much higher than anywhere else in the country, giving India a regular surplus of wheat. Punjab is also a major rice-growing state.

### People and government

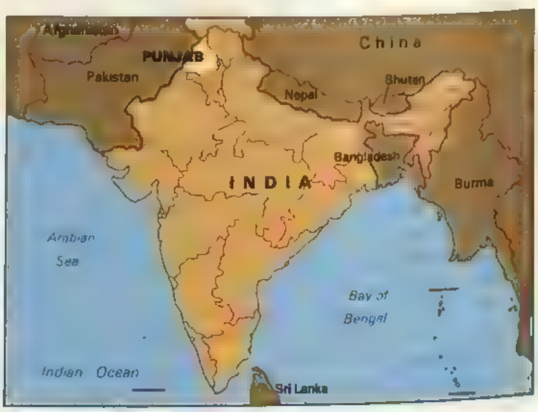
**People.** Most of the inhabitants of Punjab are descendants of tribes that invaded northwest India from around 1500 B.C. onward. The descendants include the Jats, Rajputs, and Punjabis.

Almost all of the population speak Punjabi (also spelled Panjabi), which is an Indo-European language. The remainder speak Hindi. Punjab is the homeland of the Sikhs and the only state where they form the majority. Sikhism, called *Gurmat* (the Guru's doctrine) by orthodox Sikhs, is the most recent of India's religions. It was founded by the first *Guru* (religious teacher), Guru Nanak, who lived between 1469 and 1539 (see **Nanak**). Receiving God's message, Guru Nanak was believed to have absorbed the divine spirit and become one with God. The divine spirit was believed to have been handed on through nine further gurus. The tenth Guru, Gobind Singh, decreed that in future the holy scripture *(granth)* and the Sikh community *(panth)* would take the place of the guru.

Guru Nanak composed nearly 1,000 hymns in a mixture of Old Panjabi and Old Hindi. Sikh music is immensely popular, and singing and playing religious music is part of many Sikh religious services. Guru Nanak believed that meditation should be a central part of worship. It is a path of the life of every devout Sikh today. Many Sikh homes have a room where the *Guru Granth Sahib (The Revered Book)* is kept. Some members of the house start each day with private meditation. They also recite the verses of Guru Nanak, called the *Japji*. From the time of the third Guru, Sikhs have also worshipped as congregations in temples. These are known as *gurdwara* (gateway to the Guru). The Golden Temple in Amritsar, built by Guru Arjan at the end of the 1500's, is the holiest shrine of Sikhism.

Hindus make up nearly a third of the population of Punjab. They celebrate many festivals, including *Dussehra* and *Diwali*. Islam in the region is strongly influenced by Punjabi culture and displays a distinctive character of its own. Its literature has strong connections with *Sufism* (Islamic mysticism). There are small numbers of Buddhists, Christians, and Jains.

Both men and women wear the traditional Punjabi




**Punjab** is a state in northern India, lying on the country's border with Pakistan.

**In a Punjabi village,** the animals are well fed. Punjab is the granary of India, and regularly produces a surplus of grain and other foodstuffs. Nearly three-quarters of the Punjabi people work in agriculture. Many landholdings are small, but cooperation enables farmers to use modern machines and technologies.

*salwar kamiz,* which consists of a long *kurta* (shirt) and baggy trousers drawn in at the ankle. Women usually wear an accompanying *dupatta* (shawl or long scarf).

Sikh men's dress is often associated with the "five k's": *kesh* (uncut hair), *kangha* (comb), *kirpan* (dagger or short sword), *kara* (steel bangle) and *kachh* (boxer shorts). The most important of the five is the uncut hair. It is sometimes claimed that the comb must be wooden. The dagger and the shorts reflect military influence. The bangle may be a form of charm-like thread that Hindu girls may tie on their brothers' arms.

**Government.** The governor of the state is the constitutional head of government, and is appointed by the president of India. The chief minister and his cabinet advise the governor. The state legislative assembly has 117 members. Punjab has 13 elected members in the *Lok Sabha* (lower house) and 7 nominated representatives in the *Rajya Sabha* (upper house) of the national parliament. The *collector* is the chief executive of government at the district level. There are 14 districts, which are grouped into two divisions, Patiala and Jullundur, each under the control of a divisional commissioner. The *gram panchayat* (village council) system operates at the village level.

The state capital is Chandigarh, which is also the capital of Haryana (see **Chandigarh**). The High Court is at Chandigarh and is shared with Haryana.

## Economy

**Agriculture.** About 85 per cent of the total area of Punjab is under cultivation, and 55 per cent of the population works in agriculture. The state grows a surplus of grain, especially wheat and rice. Other important grains are barley, maize, millet, and *pulses,* such as beans, peas, and *gram* (lentils). Major cash crops are cotton, oilseeds, potatoes, and sugar cane. The great productivity of Punjab is due to the combination of rich *alluvial soils* (built up by river silt), a good water supply, and a favourable climate. Farmers have also benefited from new technology, more fertile varieties of plant, and fertilizers. More than 90 per cent of Punjab's agricultural land is irrigated. Over three-quarters of a million electric and diesel pumps are used to pump water from underground. Canals irrigate about a third of the sown area. Wells and pumps serve most of the remainder. Important irrigation works developed since 1947 include the Bhakra River Valley Project, the largest of its kind in Asia.

Punjabi farmers have shown great skill in adopting new varieties of seed. Punjab's high production of wheat has made it the breadbasket of India. Landholdings are small by European standards—only 15 to 20 hectares. However, Punjabi farmers have formed cooperative societies and taken part in community development programmes which have made them the richest in India.

**Manufacturing.** Much of the state's industry is concerned with agriculture and the production of consumer goods. These goods include bicycles, electronic equipment, flour, hand tools, leather goods, machine tools, sewing machines, sugar, surgical goods, textiles, vegetables oils, and vehicle parts. Ludhiana has about 90 per cent of the country's woollen hosiery industry. Jullundur produces sports goods, and Batala is noted for its manufacture of agricultural implements.

**Transportation.** The state has a full system of roads and railways. The remotest parts of the state are linked to the road network, making easier the collection and distribution of agricultural produce. Amritsar has connections with Delhi and other north Indian centres. There is also a rail link with Pakistan, to the west. There are airports at Amritsar, Bhatinda, and Ludhiana.

### Facts in brief about Punjab

**Population:** *1991 census*—20,190,795.
**Area:** 50,362 km².
**Capital:** Chandigarh.
**Largest towns:** Amritsar, Chandigarh, Ludhiana, Jullundur.
**Chief products:** *Agriculture*—flour, maize, milk, millet, rice, sugar cane, wheat. *Manufacturing*—agricultural implements, car parts, bicycles, electrical goods, textiles.

**Tourism.** There is only a little tourism in the state. Punjab has comparatively few historical sites and its scenery is not spectacular. Political troubles in the state also deter visitors. However, tourists do visit Chandigarh, Jallianwalla Bagh, the Bhakra Dam, and the Golden Temple at Amritsar.

## Land

**Location and description.** Punjab shares an international border with Pakistan to the west. Rajasthan and Haryana lie to the south, and Himachal Pradesh and Jammu and Kashmir are to the north.

**Land features.** Almost the whole of the Punjab is a gently sloping plain, falling from 275 metres in the northeast to about 165 metres in the southwest. Its flat, alluvial soils are well watered and very fertile. There are sand dunes in the northwest, near the border with Rajasthan. To the northeast of the plain, a narrow belt of gently undulating foothills leads to the Siwalik Hills. The Siwaliks rise to about 900 metres.

**Climate.** Punjab has a continental climate. Between November and February, daytime minimum temperatures range between 5° C and 9° C. Nighttime temperatures occasionally drop to freezing point. Daily maximum winter temperatures range between 19° C and 27° C. Humidity in winter is very low. The summers are very hot, with an average daily temperature in May and June of 40° C. Temperatures occasionally reach 45° C.

Annual rainfall ranges from about 125 centimetres in the Siwalik Hills to about 35 centimetres in the southwest of the Punjab. Amritsar receives about 65 centimetres of rain per year, of which 70 per cent falls during the *monsoons* of July to September (see **Monsoon**). About 15 per cent of annual rainfall is brought by cyclones between December and March.

Large areas of the Punjab were deforested as land was needed for cultivation. Much of the Siwaliks, which once supported tropical deciduous forests of jujube, *kikar* (gum arabic), pipal, and *shisham* (a valuable building timber), now have a covering of bush.

Wild animal life is limited. Local animals include various species of deer, and foxes, jackals, *nilgai* (blue bull),

### Places to visit

Following are brief descriptions of some of the interesting places to visit in Punjab:

**Amritsar** is the site of The Golden Temple, the holiest shrine of the Sikh religion. The site has been sacred to Sikhs since the time of the fourth Guru in 1577. Guru Ram Das heard that a cripple had been cured by a miracle at a small pool on the site. He enlarged the pool, which eventually became the focus for the new temple and town. The Sikh ruler Ranjit Singh (1799-1839) had the temple rebuilt in marble with a gilded dome. The four doors of the temple are always open. The holy book, the *Guru Granth Sahib*, is kept on the ground floor.

**Chandigarh** was designed to be the new capital of Punjab after Lahore, the previous capital of the region, had been allocated to Pakistan in 1947. Notable public buildings include the Secretariat, the High Court, and the Legislative Assembly.

**Ludhiana** is a major market town and a rapidly growing centre for small industry. The tomb of the Muslim saint Pir i Dastgir is visited by Muslim pilgrims.

**Patiala** has the Bahadurgarh, an impressive fort built in the 1700's. It has two huge, concentric walls, surrounded by a moat.

rabbits, and wild boar. The birdlife is richer, and includes coel, cranes, geese, herons, and peacocks. Cobras, kraits, and vipers are all poisonous snakes and are relatively common in summer.

**Rivers and lakes.** The two major rivers of Punjab, the Sutlej and the Beas, rise in the Himalaya. Bhakra Dam and lake in Himachal Pradesh lie on the Sutlej River.

## History

**Origins.** Before the rise of the Indus Valley civilization nearly 5,000 years ago, there were fortified towns in what is now Punjab. The area was brought into the Harappan civilization until about 1700 B.C. The Aryans, advancing from the northwest around 1500 B.C., completely overran the area (see **Aryans**). Successive invaders were assimilated with the Aryans and formed the ethnic stock of the Punjabis, Jats, and Rajputs.

The area played an important part in the development of Hindu beliefs, for there the ideas of the *Vedas*, the most sacred of Hindu religious books, took shape. In the

**Sirsa Aqueduct,** near the state capital of Chandigarh, is part of the Punjab canal system. Much of Punjab's agriculture depends on irrigation, and the canal system provides water for about half the state's crops.

**Cattle** are treated with special respect by most Indians, including those who are not Hindus. These Zebu cattle have been brought to a Punjab market. Milk and milk products are important in the Punjab economy.

200's B.C., it was brought into the Maurya Empire. About 1,500 years later, it became a vital region for the Muslim kings of the Delhi Sultanate. It became a central region for the Mughal emperors.

The word Punjab is derived from the Persian words *panj* (five) and *ab* (water) and was the name applied to the region of the five rivers—Jhelum, Chenab, Ravi, Beas and Sutlej.

**Rise of Sikhism.** During the early 1500's, the preaching of the religious teacher Guru Nanak in the Punjab region inspired the development of the Sikh religion. Nanak became the Sikh's first *guru* or leader. In 1577, the fourth guru Ram Das founded the city of Amritsar. Guru Arjan built the Golden Temple at the end of the 1500's.

Banda Singh laid the foundations of the Punjab when he organized a band of Sikhs and won shortlived independence from the Mughals in 1709-1710. The Mughals executed Banda Singh in 1716. After 50 years of struggle against the Afghans and Mughals, the Sikhs established their own rule over the region in 1765. Ranjit Singh (1780-1839) welded the separate parts of the Punjab into a powerful state.

**British rule.** On the death of Ranjit Singh, there was disunity among the Punjabis, and they came into conflict with the British. After two wars, the Sikhs accepted British rule. Reluctantly, the Sikhs endeavoured to work in harmony with the British rulers. In the Indian Revolt of 1857, the Sikhs fought in support of the British. During World War I (1914-1918), the Punjab supplied 60 per cent of the Indian troops.

After the war, in 1919, the Punjab economy worsened and relations between the Sikhs and the British suffered. Strikes took place frequently and the brutality of the British in quelling demonstrations worsened matters. A massacre at Jallianwala Bagh, Amritsar, in 1919, was the climax of this period.

**Independence.** Indian and British leaders agreed to *partition* (divide) India into separate countries. The western part of the Punjab and eastern Bengal became the independent country of Pakistan on Aug. 14, 1947.

At that time, 5 million of India's 6 million Sikhs lived in the newly divided state of Punjab. They constituted 55 per cent of the population. Tens of thousands were killed in the fighting between different religious groups that accompanied partition.

The state of Punjab did not satisfy all of the Sikh demands. Some of the Sikhs were afraid of the social changes which were taking place as the state developed economically. Such people attacked many modern trends.

**Related articles** in *World Book* include:

Adi Granth
Amritsar
Aryans
Chandigarh
Delhi Sultanate
Haryana
India
India, Government of
India, History of
Jallianwala Bagh massacre
Monsoon
Mughal Empire
Nanak
Punjab (region)
Sikhism
Vedas

**Outline**

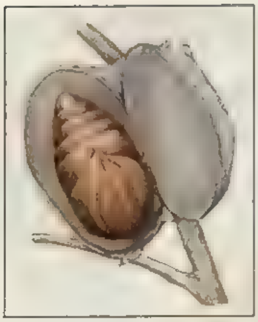
**I. People and government**
- A. People
- B. Government

**II. Economy**
- A. Agriculture
- B. Manufacturing
- C. Transportation
- D. Tourism

**III. Land**
- A. Location, description
- B. Land features
- C. Climate
- D. Rivers and lakes

**IV. History**

**Pupa** is the relatively inactive stage in the *metamorphosis* (development) of most insects. In *complete metamorphosis,* the larva feeds until fully grown (see Larva). It then moults into the pupa, a temporary form in which the adult structures develop. The adult insect emerges by splitting open the pupal "skin." The pupal stage may last a day or two, or up to one or more years, depending on the species. This stage enables some adult insects, such as butterflies, to have features that differ greatly from those of the larva. It also allows the developing insect to avoid extreme heat and cold, famine, and drought.



**Pupa**

Butterfly and moth pupae are mummylike with the wings, antennae, and legs encased in the pupal shell. The pupae of beetles, lacewings, and bees have legs and antennae that hang free. Many insects form a cocoon of silk or other materials and pupate in it. Most moths form cocoons. The butterfly pupa, called a *chrysalis,* hangs from a silklike pad and does not have a cocoon. The house fly and related flies inflate the next-to-last larval skin to form a cocoon called a *puparium.*

See also **Butterfly** (The pupa; picture); **Chrysalis**; **Cocoon**; **Fly** (Pupa; picture); **Metamorphosis**; **Moth** (The pupa; picture).

**Pupfish** is any of about 30 species of small fish that live mainly in springs and streams in the Southwestern United States and Mexico. Pupfish have inhabited these waters since the last Ice Age, about 50,000 years ago. At that time, rivers and lakes covered the area, much of which is now desert. Isolated groups of pupfish survived after most of the water had dried up. One species, the *Devil's Hole pupfish,* has lived over 20,000 years in a deep spring in Nye County, Nevada, U.S.A.

Several species of pupfish have become extinct, and other species are endangered. In the 1970's, scientists and conservationists began working to protect the surviving species. The Devil's Hole pupfish has been legally protected since 1976. In the past, the population of this species had been reduced to only about 200.

Pupfish can live in water where few plants and animals can survive. Some pupfish normally withstand water temperatures of up to 42° C. Pupfish are, on average, about 4 centimetres long. The females and young are olive brown and white, with black bars on their sides. The males are blue and purple, with black bars and dark-edged fins.

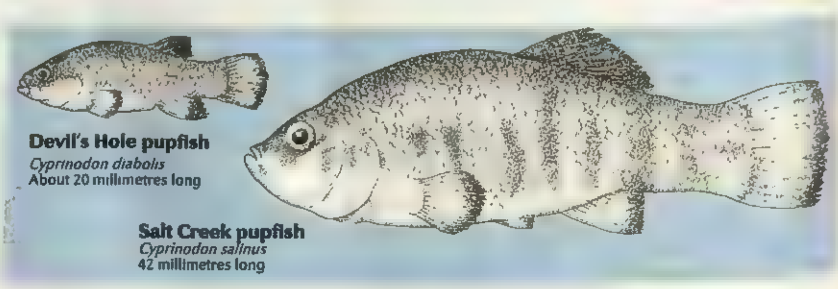
**Scientific classification.** Pupfish belong to the killifish family, Cyprinodontidae. They are genus *Cyprinodon.* The Devil's Hole pupfish is *C. diabolis;* the Salt Creek pupfish is *C. salinus.*

**Pupil.** See Eye (The uveal tract; picture: The iris).

**Pupin, Michael Idvorsky** (1858-1935), was a Serbian-American electrical engineer, educator, and inventor. In 1900, he patented the *loading coil,* a device that improved telephone sound quality and enabled people to talk on the telephone over much greater distances. Pupin went to the United States in 1874 and taught at Columbia University from 1889 to 1931. In 1924, he received a Pulitzer Prize for his autobiography, *From Immigrant to Inventor* (1923). He was born in Idvor, north of Belgrade in what became Yugoslavia.

**Puppet** is an artificial figure whose movements are controlled by a person. Puppets can be moved by hand or by strings, wires, or rods. A figure may represent a person, an animal, a plant, or an object. Puppets usually

**Puppet shows** are a popular form of entertainment for young people. In the puppet show pictured above, three comical puppets are amusing a group of children at an outdoor festival.




**Pupfish** have lived in the waters of southwestern North America for thousands of years. The Devil's Hole pupfish is found only in a small spring in California. The Salt Creek pupfish lives in a California stream where temperatures reach over 38° C.

**Marionettes** are moved by strings or wires attached to their body and controlled by puppeteers who are hidden above the stage. The scene on the left shows three women battling a serpent in a marionette version of the opera *The Magic Flute.*

appear as characters in plays called *puppet shows.* A person who operates a puppet is called a *puppeteer.*

Many children make puppets from such cheap materials as cloth and wood, or from such items as milk cartons and rags. They write puppet shows and operate the puppets, varying their voice for each character. A table or bookcase can serve as a stage for a puppet show. A puppeteer can also work behind a blanket or sheet tacked across the lower part of a doorway. The puppeteer is concealed, and so the audience sees only the puppets performing in the upper part of the doorway.

Some teachers use puppets to make schoolwork more interesting. For example, a history class may use puppets to act out a famous historic event. Students can improve their knowledge of a foreign language by writing and performing puppet shows in that language. Creating a voice for a puppet has helped some students overcome a speech problem. In developing countries, puppet shows have been used to teach a range of subjects, including health care and modern farming methods.

People have enjoyed puppets for thousands of years. Puppetlike figures have been found in tombs and ruins in ancient Egypt, Greece, and Rome. The first puppets were probably used in religious ceremonies. Priests secretly moved the eyes or arms of an idol or religious carving to impress the people watching.

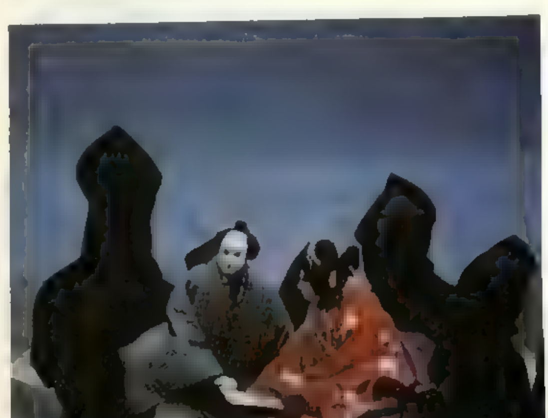
There are three main kinds of puppets: (1) hand puppets, (2) marionettes, and (3) rod puppets. Many puppets have features of more than one type.

**Hand puppets** are the most common puppets. One variety, the *glove* or *fist* puppet, consists of a hollow head attached to a glove or a piece of cloth that serves as the puppet's body. The body fits over the hand of the puppeteer, who puts a thumb into one of the puppet's arms. One or two fingers go into the other arm, and the remaining fingers are placed in the head. These puppets can pick up and throw things and can gesture strongly with their head and arms. Most glove puppets have no legs or feet.

Perhaps the most famous glove puppet character is Punch, the star of English puppet shows called *Punch-and-Judy shows.* Punch was introduced into England in 1662 (see **Punch and Judy**). Puppet characters that resemble Punch are popular in several countries, including France, Germany, Italy, the Netherlands, and Switzerland. Glove puppets have become a popular feature of several children's television programmes, such as "Sesame Street" and "The Sooty Show."

The simplest kind of hand puppet is probably the *finger puppet.* Two fingers of the puppeteer's hand serve as the puppet's legs. The face may be painted on the back of the hand, or a paper head can be fastened to the hand with a rubber band.

Another type of hand puppet, the *muppet,* was developed for television by the American puppeteer Jim Henson. This small puppet has a wide mouth, with the pup-



**Rod puppets** are featured in a traditional form of Japanese theatre called *bunraku, above.* Puppeteers use rods to operate the figures, which stand about 120 centimetres tall. The puppeteers, dressed in black, work in full view of the audience.

**Shadow puppets** perform behind a screen. A light from above and behind the puppets creates shadows on the screen. The audience sees only the shadows. Shadow plays based on Hindu myths, *above*, are the most popular form of theatre in Indonesia.

peteer's thumb forming the jaw. The fingers form the upper part of the muppet's face. The puppeteer moves various fingers to change the muppet's expression and the shape of its head. The puppeteer's other hand, which is concealed in a glove, forms the muppet's body or hand.

**Marionettes** are puppets that are controlled by strings or, in some cases, by wires. A marionette has a complete body, with head, trunk, arms, hands, legs, and feet. Strips of cloth or other flexible material connect the various parts of the marionette's body. Most marionettes have strings that run from the head, shoulders, hands, and knees to a small wooden frame. One or more puppeteers, who are hidden above the stage, operate the marionettes by moving the strings where they are fastened to the frame.

The word *marionette* comes from *Little Mary*, a type of puppet of the Middle Ages. During this period, many people could not read or write. Priests used Little Marys to teach stories from the Bible. Marionette shows gradually became comic plays that were intended to entertain rather than teach religious lessons. But the plays grew so coarse and worldly that religious authorities refused to let them be performed in churches. Marionette shows then became *street entertainments* that were performed in parks and at fairs.

**Rod puppets** are operated by rods or sticks, usually from below the stage. One kind of rod puppet, the *marotte*, consists only of a head mounted on a stick. Some rod puppets have rods attached to movable arms and hands. Rod puppets are often used to represent figures other than people and animals. For example, they may portray clouds, flowers, hats, trees, or just simple shapes.

Japan has a well-known form of puppet show called *bunraku* (doll theatre). The puppets stand about 120 centimetres tall. They look realistic, with flexible joints and movable eyes, mouth, and eyebrows. Puppeteers oper-

**How to make a hand puppet**

**To make the face,** the girl uses common materials found in the home. She first glues on an eye made of felt to the end of a white sock, *left*. The sock serves as the puppet's head and body. She then sews on eyelashes made of yarn, *right*.

**To complete the head,** the girl adds hair by sewing long strands of yarn onto the sock, *left*. She draws the puppet's mouth with ink, *right*. She also used ink to draw the eyebrows. She can add other decorations to the head and body.

**Two hand puppets** perform on a box that serves as a stage. The puppet on the left has a head and body made from paper bags and decorated with coloured paper, straws, and yarn.

ate them with rods from behind, in full view of the audience. Many important Japanese dramatists of the late 1600's and 1700's wrote plays especially for the doll theatre. See **Drama** (Asian drama [Japan]).

**Shadow plays** are a special type of puppet show in which all types of puppets can be used. The puppeteer operates the puppet against a thin screen made of silk or cotton. A strong light shines on the screen from behind and above. The audience, which sits on the other side of the screen, sees only the moving shadows of the puppets.

One kind of puppet, a flat figure made of leather, is made especially for shadow plays. Such puppets, which are popular in Asia, may have movable parts operated by rods made of bamboo or animal horn. The Chinese and Turks create coloured shadows on the screen by dyeing the leather figures. In Indonesia, a popular form of puppet theatre called *wayang kulit* (leather puppets) presents plays based on Hindu myths. The performances begin in the early evening and last until dawn. See **Indonesia** (Arts).

**Dummies** are puppets that play an important part in ventriloquism. The ventriloquist pretends to talk to the dummy, which is held on the knee or on a chair. The ventriloquist "throws" his or her voice so that the dummy seems to be speaking. Rods and strings inside the puppet enable the ventriloquist to move the puppet's head and parts of its face from the back. See **Ventriloquism**.

**Organizations for puppeteers** help people improve their technique with puppets. The Puppeteers of America have members in the United States, Canada, and about 20 other countries. They hold an annual festival in North America. The Union Internationale des Marionettes (UNIMA) is an international organization of puppeteers, with headquarters in Warsaw, Poland, and national centres in more than 50 countries. In the United Kingdom, the Puppet Centre Trust provides courses, lectures, and demonstrations. It has a reference library devoted to puppetry and related subjects.

**Puppy.** See **Dog** (Caring for a dog).

**Purbeck** (pop. 42,600) is a local government district in the south of Dorset, England. The district includes the Isle of Purbeck and has much attractive coastline. Swanage is a popular seaside resort. Inland, agriculture provides the main industry, although extractive industries are quite important. Near Wareham is Wytch Farm, Britain's largest onshore oilfield, which also produces natural gas. Nearby, pottery clay is mined. The district also has sand and gravel quarries. Marble was once quarried in Purbeck, and a local quarry still produces a good building stone called *Purbeck*. Wareham is the district's administrative centre, and it has several light industries.

See also **Dorset**.

**Purcell, Henry** (1659?-1695), was an English composer during the baroque period. He wrote religious music, as well as music for the theatre and ceremonial music for the English court.

Purcell is admired for his original harmonies and for his skilful setting of the English language in his choral music. Purcell was aware of musical developments in other countries. His trio sonatas and many of his songs for the theatre are modelled on the Italian style. Some of his religious anthems imitate French fashions.

Purcell wrote one of the earliest English operas, *Dido and Aeneas* (1689). It contains a famous song, "When I am laid in earth" ("Dido's Lament"), composed in one of Purcell's favourite forms, called *ground bass*. This form uses a short melodic theme in the bass part repeated over and over with changing harmonies.

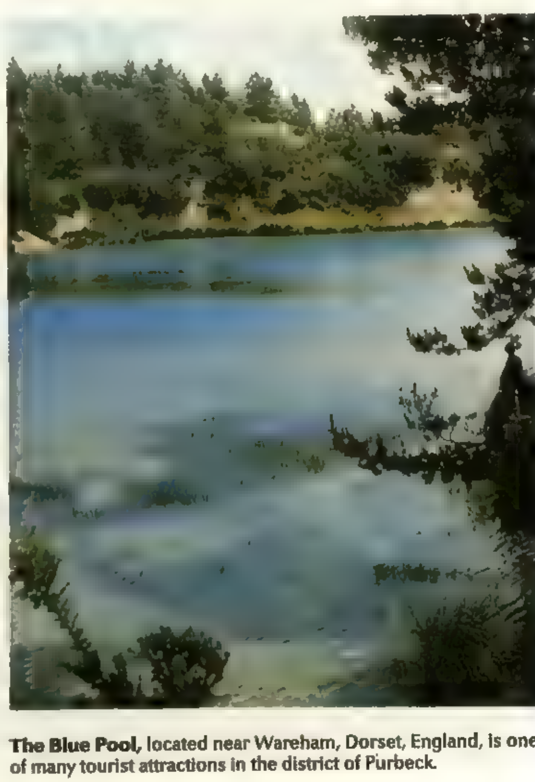
Purcell was born in London. As a boy, he sang in the choir of the Chapel Royal, the king's private chapel. In 1679, Purcell was organist of Westminster Abbey, and in 1682 he became an organist of the Chapel Royal.

**Purchasing power.** See **Inflation** (introduction).

**Purgatory** is a state, according to Roman Catholic tradition, in which people who have died atone for their sins before being admitted to the vision of God in heaven. In purgatory, those who have been in the friendship of God make full amends for their failings by suffering. People can reduce their future suffering by engaging in various religious or pious acts before death. Those who are already in purgatory can be helped by the prayers of the living.

**Purim** is a joyous Jewish festival celebrated in February or March, on the 14th day of the Hebrew month of Adar. It commemorates the rescue of the Jews of Persia from a plot to kill them.

The story of Purim is told in the Book of Esther in the Bible. Esther was the beautiful Jewish queen of King Ahasuerus of Persia, but the king did not know she was Jewish. His wicked minister, Haman, persuaded Ahasuerus to have all Jews in the empire killed. Esther then told the king she was Jewish and pleaded with him to spare the Jews. Ahasuerus ordered that Haman be killed instead.



**The Blue Pool,** located near Wareham, Dorset, England, is one of many tourist attractions in the district of Purbeck.

Jews celebrate the survival of their people with great merriment. The Book of Esther, called the Megillah, is read in the synagogue. Whenever Haman is mentioned in the story, the congregation, especially the children, make noise to blot out his name. The people send gifts of food to their friends and neighbours and to the poor. They also dress in costumes of the leading characters in the Book of Esther and hold carnivals and dances. Some Jews honour Esther by fasting the day before Purim, called *Taanit Esther*.

The word *Purim* probably comes from the Hebrew word *pur,* meaning *lot.* Haman had used lots to determine the day of execution for the Jews.

See also **Esther, Book of.**

**Puritans** were members of a religious and social movement of the 1500's and 1600's. The movement began in England and spread to America where it greatly influenced social, political, and religious institutions. Such religious denominations as Congregationalism and Unitarianism developed from Puritan beliefs.

**Puritan beliefs** developed from the teachings of religious reformers, such as John Wycliffe and John Calvin. Wycliffe was a famous professor of philosophy at Oxford University during the 1300's. Calvin was a leader of the *Reformation,* the religious movement of the 1500's that gave rise to Protestantism.

The Puritans considered the Bible as the true law of God that provided guidelines for church government. They wished to shape the Church of England to meet their ideals. They called for a less priestly church that emphasized preaching. Puritans believed that all Christian churches should be organized through councils called *presbyteries* or *church courts* rather than under bishops, as in the Church of England. Some Puritans believed that each congregation was a complete church in itself and should have total control of its own affairs.

The Puritans emphasized Bible reading, prayer, and preaching in worship services. They simplified the ritual of the sacraments. They also wanted more personal and fewer prescribed prayers. The Puritans stressed grace, devotion, prayer, and self-examination to achieve religious virtue.

**History.** The term Puritan was first used in the late 1500's to identify a party within the Church of England. The party sought to make further changes in the church than had been brought about by Protestant reforms during the reigns of King Henry VIII, King Edward VI, and Queen Elizabeth I. Defenders of these reforms called the party members Puritans because of their proposals to "purify" the church.

As early as the 1520's, English Protestant leaders had demanded reforms along the lines that were later called Puritan. In the 1520's and 1530's, William Tyndale published pamphlets and English translations of the Old Testament and New Testament of the Bible designed to encourage such reforms. Hugh Latimer, who became an important Protestant bishop, also had raised such protests to purify the church.

Many English Christians agreed with the demands of Tyndale and Latimer that the church and the government be operated according to the Bible. These Christians believed that the Bible governed all human affairs. John Wycliffe had taught this doctrine at Oxford in the 1300's. Under King Edward VI and Queen Elizabeth I, these teachings received support from English clergymen who followed Calvin's doctrine that the New Testament described how the church should be run.

During the 1600's, the Puritans increasingly opposed the political and religious policies of the Stuart rulers, King James I and his son, King Charles I. In 1604, James I called the Hampton Court Conference to settle disagreements within the Church of England. However, James refused to bring about the reforms the Puritans sought, except for a new translation of the Bible, now called the King James Version. Charles I continued to ignore Puritan demands for reform.

**Puritans** opposed elaborate ritual in the Church and advocated that people should lead an austere life. They flourished in the 1600's.

The Puritans gained in strength in Parliament, and repeatedly introduced legislation against the Crown's policies. In 1642, civil war broke out between the Crown's forces, called *Royalists* or *Cavaliers*, and the Puritans, called *Roundheads*. The Puritans received the name Roundheads because they cut their hair short. The English Civil War is also called the *Puritan Revolution*.

The Puritans, led by Oliver Cromwell, won a series of victories and took control of the government in 1649. The Puritans closed theatres and passed other unpopular measures. Their political power ended after Cromwell died in 1658. In 1660, the Stuart dynasty returned to the throne.

After the Restoration, Charles II's parliament passed a series of acts against the Puritans that became known as the *Clarendon Code*. One of these, the Act of Uniformity, laid down conditions for the clergy that Puritans could not accept (see **Clarendon Code**). Many Puritans left the Church of England and became Nonconformists.

**Puritans in America.** During the 1600's, some Puritan groups believed that reform of the Church of England was impossible and departed to settle in North America. They founded settlements in Virginia and along the New England coast, especially in Massachusetts Bay Colony and Connecticut. The Puritans shaped religion, social life, and government in North America to their ideals. Their strong belief in education led them to establish Harvard and Yale as colleges and to require a system of grammar schools in the colonies. The Puritans organized their government according to the teachings they found in the Bible and on the basis of their English experience.

Late in the 1500's, some Puritans separated from the Church of England and set up their own congregations. Such groups were called *Separatists*. A group of English Separatists first went to Holland and then founded Plymouth Colony in what is now Massachusetts, in 1620. This group of Puritans is better known as the *Pilgrim Fathers*. Some Separatists moved to Rhode Island and became Baptists. Others joined the Massachusetts Bay Puritans and became Congregationalists. Thus, while the Puritan movement in England died down, it influenced Protestant denominations in England and America.

**Puritan influence** also shaped political and social institutions in England and the American Colonies. In England, the Puritan Revolution led to a greater emphasis on *limited* or *constitutional monarchy*, in which a constitution, legislature, or both limit the power of a ruler. The Puritans' belief in government by contract from the governed influenced the development of American democratic principles.

Over time, the term *puritan* (or *puritanical*) has broadened to mean a strictness in morals or religious matters. The term is commonly applied to cultural traits found in the literature of and social attitudes shared by the New England colonies of North America. Such traits include an emphasis on education and the glorification of hard work.

The word puritan has also been used to describe reforming attitudes and activities that were not part of the culture of the Puritans. For example, *prohibition*, the forbidding of the sale or manufacture of alcoholic beverages, and *temperance*, the avoidance of alcohol, are often called puritan movements. However, the Puritans did not disapprove of the use of alcohol. The term puritan has also come to describe moral attitudes and values that characterize modern movements for rapid social change that require discipline and hard work.

Many social scientists have studied the role of the Puritans in the development of modern social patterns. The German sociologist Max Weber associated the Puritan belief in hard work with the rise of the free enterprise system. Others emphasize the connection between the behaviours and beliefs of the Puritans and those of modern revolutionaries.

**Related articles** in *World Book* include:

Calvin, John
Congregationalists
Massachusetts Bay Colony
Pilgrim Fathers
Wycliffe, John

**Purple flag flower,** also called *wild iris*, belongs to a *genus* (group) of plants that grow mainly in Australia, but also extend north to the Philippines. There are about 20 kinds in Australia, of which 14 grow only in the southwest province of Western Australia. The others are widely distributed over the rest of the continent. The plants are tufted, with underground stems and rather hard, narrow, grasslike leaves. The fragile flowers have three thin purple or white petals. The flowers resemble those of the common garden irises. The seeds of the purple flag flower are produced in erect brown containers that split to release them.

**Scientific classification.** Purple flag flowers belong to the iris family, Iridaceae, and to the genus *Patersonia*.

**Purslane** is the name of about 40 *species* (kinds) of fleshy leaved trailing, annual plants. *Common purslane* is a weed of waste ground. It has yellow flowers that open on sunny mornings. It stems may grow up to 35 centimetres long. A subspecies of this plant is cultivated as a vegetable, especially in Europe. In addition, common purslane is used in India and China as a medicinal herb, especially as a poultice to help heal ulcers and wounds.

Purslane

**Scientific classification.** Purslanes make up the purslane family Portulacaceae. Common purslane is *Portulaca oleracea*.

**Purus River** is one of the chief tributaries of the Amazon River. For location, see **Brazil** (terrain map). The Purus is one of the longest rivers in South America. It drains an important rubber-producing region. The river rises in the eastern lowlands of Peru and flows 3,380 kilometres before entering the Amazon in northwestern Brazil.

**Pus** is a yellow-white liquid that the body produces during infection. It has lymph and white blood cells. At one time doctors spoke of *laudable* pus, which was supposed to indicate a desirable condition in a wound. They no longer believe that pus is "laudable." However, doctors do recognize the formation of pus as one method by which the body is able to fight infection.

See also **Abscess**; **Inflammation**.

**Pusan** is South Korea's major port and the country's second largest city. Pusan Tower, *left*, offers a fine view of the city from its observation deck.

**Pusan** (pop. 3,516,807) is the second largest city and the major port in South Korea. Only Seoul has more people. Pusan lies on the southeast coast of the Korean Peninsula. For location, see **Korea** (map).

Pusan's harbour can accommodate about 80 large ships at a time, and the port handles millions of tons of cargo yearly. The city is an important centre of South Korea's fishing industry. Pusan is also an administrative, commercial, and industrial centre. The many industries in and near the city produce chemicals, electric and electronic equipment, machinery, plywood, rubber goods, ships, and textiles. Pusan has an underground rapid-transit system and an international airport.

Pusan is also a tourist centre. The region's beaches and hot springs attract many visitors. Two religious landmarks in the Pusan area also attract visitors. Tongdosa and Pomosa are both large, beautiful Buddhist temple-monastery complexes of buildings that lie on the slopes of wooded hills. The United Nations Cemetery is near Pusan. It contains the graves of armed forces personnel from nations that fought as allies in the Korean War (1950-1953).

Pusan dates from ancient times. During the Korean War, it served as the temporary capital of South Korea and was the chief landing and supply port of the United Nations forces. Pusan's population has increased sharply since the war. Today, the city suffers from a shortage of housing.

See also **Asia** (picture: A fish market).

**Pusey, Edward Bouverie** (1800-1882), an English theologian, was one of the founders of the Tractarian movement (see **Tractarians**). He became associated with John Keble and John Newman in their struggle to bring the Church of England closer to the principles of its founders. Pusey financed the building of several churches in London and of St. Saviour's in Leeds. In 1884, his friends founded Pusey House, Oxford, to carry on his work. He was born at Pusey, in Oxfordshire.

See also **Church of England**.

**Pushkin, Alexander** (1799-1837), is considered Russia's greatest poet. Pushkin is best known for his long narrative poems, but he also wrote many beautiful short lyric poems, plays in verse, and prose short stories. Several of his works inspired ballets and operas by some of Russia's greatest composers.

Pushkin's most famous poem is *Eugene Onegin* (1825-1832), a novel in verse. The title character is intelligent, good-hearted, and liberal, but he lacks moral discipline and a serious occupation or purpose in life. As a result, he destroys himself and those around him. Much of the poem deals with Onegin's romantic relationship with a beautiful country girl named Tatyana. These two figures, the weak Eugene and the sincere Tatyana, served as models for many characters in Russian literature.

Pushkin's drama *Boris Godunov* (1825), written in blank verse, introduced Shakespearean historical tragedy to the Russian stage. The play tells the story of a czar who is haunted by guilt over a murder he committed in order to reach the throne. Pushkin wrote many lyric poems about love, the fear of madness, and the obligation of the poet to lead society to the truth. The most popular of Pushkin's prose stories is "The Queen of Spades" (1834).

Alexander Sergeyevich Pushkin was born in Moscow. One of his great-grandfathers was a black Abyssinian courtier to the Russian ruler Peter the Great. Pushkin took great pride in his black ancestry and noble heritage. He began writing poetry at the age of 12, about the time he started school. After leaving school in 1817, Pushkin took a job in the civil service but spent most of his time participating in the social life of St. Petersburg.

The czar's secret police began to watch Pushkin after he wrote several poems that criticized important government officials. In 1820, Pushkin was exiled to southern Russia because of his poems. In 1826, the new czar, Nicholas I, summoned Pushkin to Moscow and gave him a personal pardon. By this time, he had become Russia's leading poet. For the rest of his life, Pushkin combined writing with historical research. In 1836, he founded a literary journal called *The Contemporary*.

In 1831, Pushkin married Natalya Goncharova, a famous beauty. His wife acquired a number of male admirers, which made Pushkin intensely jealous. He particularly resented Baron Georges d'Anthès, a Frenchman living in Russia. Pushkin challenged the baron to a duel. The poet was wounded in the duel and died two days later.

See also **Russian literature** (Early romanticism); **Opera** (*Boris Godunov;* picture).

**Pushtu.** See **Afghanistan** (Ethnic groups).

**Pushtuns** are one of the largest ethnic groups in Afghanistan and Pakistan. They make up about half the population of Afghanistan and about one-fifth of the people of Pakistan. Most Pushtuns live near the border between Afghanistan and Pakistan—in eastern Afghanistan or western Pakistan.

Other names for the Pushtuns include *Pathans, Pashtuns, Pakhtuns,* and *Pukhtuns.* They speak Pashto, also called Pushtu or Pukhtu, a language related to Persian. Almost all Pushtuns are Muslims.

The Pushtuns consist of about 40 tribes divided into groups of related families. Democratic councils called *jirgah* govern tribal affairs. Although the tribes unite to fight invaders, they often feud with one another.

Many Pushtuns work as farmers, growing wheat and other grains, fruit, nuts, and sugar cane. Other Pushtuns are nomads who breed horses and herd sheep, goats, cattle, and camels. Many farmers live in homes made of sun-dried mud brick. Most nomads live in tents made of goat hair. Some Pushtuns have combined farming with nomadic herding.

Ancestors of the Pushtuns lived in what is now Afghanistan by about 4000 B.C. In the A.D. 1500's, some Pushtuns moved to present-day Pakistan. During the 1800's and early 1900's, Pushtun warriors won a series of wars with the British, who wanted control of Afghanistan. In late 1979 and early 1980, the Soviet Union invaded Afghanistan. Hundreds of thousands of Pushtuns formed guerrilla bands to fight the invaders. Others fled to Pakistan. The Soviets withdrew from Afghanistan in 1988 and 1989, and many of the Pushtun refugees returned to Afghanistan in the early 1990's.

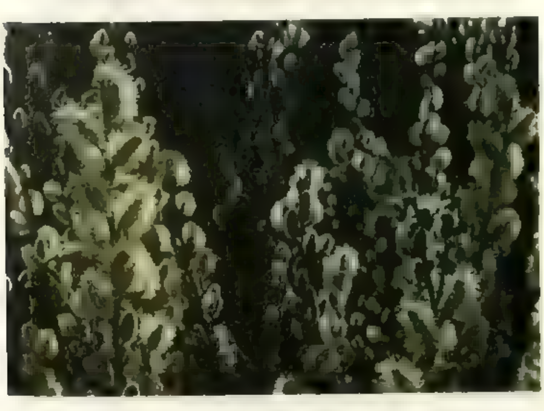
See also **Afghanistan** (People); **Pakistan** (People).

**Pussy willow,** also called *goat willow* or *great sallow,* is a shrub or small tree belonging to the willow family. It grows in damp woods in Europe and northeast Asia. The pussy willow grows to a height of about 10 metres. The bark is grey on young trees, and on older trees is brown and cracked. The leaves of the pussy willow are dark green above and the underside is covered with grey down. Pussy willow leaves are broader than the leaves of other types of willow.

In early spring, before the leaves appear, the pussy willow's flowers break out of hard bud cases. These flowers are called *catkins.* They are about 3 centimetres long. On male pussy willow trees, the catkins are oval in shape, and are covered in silky grey hairs. These later become yellow with pollen. Female pussy willow trees also have catkins. These are longer in shape and pale green in colour. Later on, they produce fluffy seeds.

**Scientific classification.** The pussy willow belongs to the willow family, Salicaceae. It is *Salix caprea.* Several other species of willow with silky catkins are also known as pussy willows.

See also **Willow.**



**Pussy willow flowers** appear in spring. At first, the flower clusters have a coat of silky, greyish-white hair. The male clusters later develop into loose masses covered with yellow pollen.

**Putrefaction.** See **Decay; Decomposition.**

**Putsch.** See **Hitler, Adolf** (The Beer Hall Putsch).

**Putty** is a filler material that is soft when applied, but slowly hardens. It is used to fill knotholes, cracks, and other defects in wood surfaces before the surfaces are painted. Putty is also placed around the edges of panes of glass to seal them in a window sash or door.

The most common putty is a mixture of powdered natural chalk, called *whiting,* and linseed oil to which a small proportion of colouring agents may be added. Putty hardens because some of the linseed oil combines with oxygen from the air, and the rest soaks into the wood.

Some projects require special, more elastic putty. This is made from vegetable oil, nondrying oils, driers that make the putty harden, synthetic fibres, a powdered limestone filler, and a colouring agent.

See also **Caulking.**

**PVC.** See **Vinyl.**

**PWV (Pretoria-Witwatersrand-Vereeniging).** See **Gauteng.**

**Pyelonephritis.** See **Kidney** (Kidney diseases).

**Pygmalion** was a sculptor and king of Cyprus in Greek legend. Disgusted by the wicked women of his day, Pygmalion carved an ivory statue of a beautiful woman and then fell in love with it. In answer to his prayer, the goddess Aphrodite made the statue a living woman. Pygmalion married her, and they had a son named Paphos.

The legend of Pygmalion has attracted many writers. The ancient Roman poet Ovid retold the story in his collection of tales called *Metamorphoses.* The best-known modern version of the story appears in George Bernard Shaw's play *Pygmalion* (1913). The play tells how an Englishman makes an elegant lady out of an ignorant girl by teaching her to act and speak correctly. The musical comedy *My Fair Lady* (1956) was based on Shaw's play.

**Pygmies** are small people. The word *pygmy* is a general term for anything small. When spelled with a capital "p," it usually refers to a member of a group of about 150,000 African people. This article tells about African Pygmies, who are also called *Negrillos.* Other Pygmies, called *Negritos,* live in parts of Asia and on some islands of the Indian and Pacific oceans (see **Negritos**).

African Pygmies live in thick tropical rainforests. Many scholars believe they once made their homes throughout central Africa. Today, most Pygmies live in parts of Burundi, Cameroon, Congo, Gabon, Rwanda, and Zaire. They occupy a smaller area than they once did. Peoples who speak Bantu languages invaded much Pygmy territory and cut down the forest to grow farm crops and to set up villages. Today, the Pygmies continue to lose territory because of the construction of roads and towns in the forest. In recent decades, the number of Pygmies who follow their traditional way of life has declined rapidly.

**Characteristics.** Most Pygmies are between about 1.2 and 1.4 metres tall. They have reddish-brown skin and tightly curled brown hair. Most of them have round heads and broad, flat noses. They have short legs, long arms, and protruding abdomens.

No one knows definitely why Pygmies are small. Some scientists believe that the physical characteristics of Pygmies developed over thousands of years, enabling

Nadine Peacock, Anthro-Photo

**Pygmy dancers** perform in a small clearing carved out of the dense jungle. Each African tribe has its own symbolic and traditional dances that are passed on from generation to generation. Each dance tells a story.

them to adapt to their surroundings. The colour of Pygmies' skin serves as a camouflage in the forest, and their size and body build enable them to move quickly and quietly. Some scientific studies indicate that Pygmies lack the usual amount of a body chemical believed to affect human growth.

**Way of life.** Pygmies have traditionally lived by hunting and gathering. The men hunt antelope, birds, buffaloes, elephants, monkeys, and other animals. Most of the hunters trap animals in large nets and kill them with spears. Some Pygmies hunt with small bows and poisoned arrows. The women gather berries, mushrooms, nuts, and roots. Pygmies also like to eat honey.

Some Pygmies live in small bands of fewer than 50 members. Each band has its own territory in the forest. Pygmies establish temporary camps in clearings, and they build huts of saplings and leaves. A band moves its camp to a new area of the forest when the food supply runs low.

A Pygmy band has no formal leadership. Members of each band make decisions and solve problems by general discussion. Most Pygmies marry people of other bands. Ties of family and friendship link various bands, and a family may leave its band to join another one at any time.

Pygmies speak the same Bantu languages as their crop-growing neighbours. They trade meat with these neighbours for knives and other metal tools and for various agricultural products, such as bananas, maize, and rice.

Pygmies see the forest as the giver of all life. It provides them with clothing, food, and shelter. In return, Pygmies try not to harm the forest. They perform various ceremonies to maintain friendly relations with the natural and supernatural worlds.

See also **Africa** (Racial groups; picture: Congolese Pygmy).

**Pyle, Howard** (1853-1911), an American painter, became one of the most influential illustrators of his time. As an art teacher, Pyle helped develop the talents of American artists such as Maxfield Parrish and N. C. Wyeth.

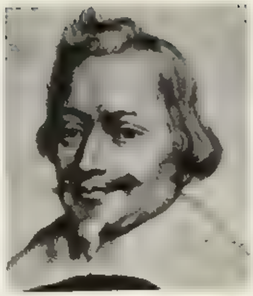
Pyle combined vigorous draughtsmanship with a rich imagination. His sense of pictorial design and his firm, expressive style of drawing has been compared with that of the German Renaissance artist Albrecht Dürer. Pyle's energy and creativity enriched the tradition of American illustration.

The books that Pyle wrote and illustrated continue to attract young readers. They include *The Merry Adventures of Robin Hood* (1883), *Pepper and Salt* (1886), *Twilight Land* (1895), and *The Story of King Arthur and His Knights* (1903). For many years, Pyle illustrated pages in *Harper's Monthly* and drew illustrations for books written by other authors.

Pyle was born in Wilmington, Delaware, U.S.A., and studied at the Art Students' League in New York City. He was an art teacher at Drexel Institute in Philadelphia.

**Pyloric sphincter.** See **Stomach** (The stomach's work).

**Pym, John** (1584-1643), was a prominent English parliamentarian during the 1600's. He entered Parliament as member for Calne in 1614. Later, he represented Tavistock. During the reign of James I, he obtained great influence by his opposition to arbitrary royal actions. He continued this policy after Charles I came to the throne. In 1626, he played a leading part in the impeachment of the Duke of Buckingham and was imprisoned.


**John Pym**

In 1641, Pym became chancellor of the exchequer. He led the Long Parliament, and was largely responsible for the impeachment of the Earl of Strafford. He was an ardent defender of the power of Parliament and moved the impeachment of the bishops, who had declared its proceedings sinful.

When the Civil War broke out in August 1642, Pym was a member of the Parliamentary Committee of Safety. Charles attempted to arrest him together with four other members of Parliament. Pym escaped, but remained in London to help the Parliamentary cause. He later made an alliance with the Scots.

Pym was born near Bridgwater, in Somerset. He studied at Oxford University and became a lawyer.

See also **Civil War, English.**

**Pyongyang** (pop. 2,639,448) is the capital and largest city of North Korea. The city is also the cultural, economic, industrial, and military centre of the country. The North Korean Workers' (Communist) Party, which controls the government, has its headquarters in Pyongyang. Party leaders in Pyongyang make all decisions affecting the nation's political, cultural, economic, and social programmes and see that they are carried out. The city lies in west-central North Korea, along the Taedong River. For the location of Pyongyang, see **Korea** (map).

Modern apartment and office buildings line Pyongyang's wide avenues. Pyongyang is the home of Kim Il Sung University. One of the city's principal structures is the large government assembly building, which houses the Supreme People's Assembly, North Korea's legislature. The annual National Fine Arts Exhibition is held in Pyongyang.

Most of Pyongyang's people work in government offices in the city or in the factories on the outskirts of the community. The factories produce industrial goods, such as farm tractors and electric locomotives.

Pyongyang was founded about 3,000 years ago. It was the capital of ancient Korea. The Chinese invaded the city in 108 B.C. and ruled it until A.D. 313. After that, a series of small kingdoms controlled the Pyongyang area. In 427, Pyongyang became the capital of Koguryo, a Korean kingdom that also ruled part of southern Manchuria. Chinese armies destroyed Pyongyang in 668. However, the Korean kingdom of Koryo rebuilt the city during the 900's.

After World War II ended in 1945, Pyongyang served as the headquarters of the Soviet occupation army,

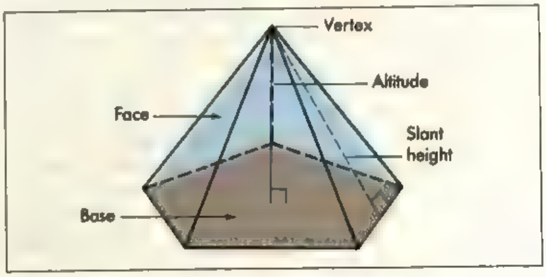

**Pyongyang** is the capital and largest city of North Korea. The central area of the city includes traditional Korean architecture, *above*, as well as modern skyscrapers.

which supported the Korean Communists. In 1945, Korea was divided into two parts. Two states, North Korea and South Korea, were established in 1948. Pyongyang became the capital of Communist North Korea. Much of the city was destroyed during the Korean War (1950-1953). However, the city was later rebuilt.

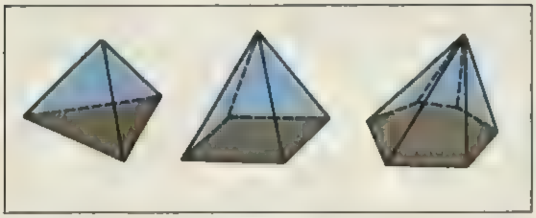
**Pyorrhoea.** See **Periodontitis.**

**Pyramid,** in geometry, is a solid figure with triangular faces that meet at a common point. The base of a pyramid is a *polygon,* a plane figure bounded by three or more sides. The number of faces in any pyramid equals

**Parts of a pyramid**



**Some kinds of pyramids**



the number of sides on its base. The point farthest from the base—at which the faces meet—is called the pyramid's *vertex.*

In a *regular pyramid,* the faces are all *congruent* (equal in size and shape). Such a pyramid has a base that is a *regular polygon*—that is, a polygon with all sides equal and all angles equal. A perpendicular line extended from the vertex of a regular pyramid meets the base at its centre. Pictured on the previous page is a regular pentagonal pyramid. Its base is a regular five-sided figure called a *pentagon.*

The *altitude,* or height, of a pyramid is the distance along a perpendicular from the vertex to the base. The *volume (V)* of any pyramid may be found by using the following formula:

$$V = \frac{1}{3} Bh$$

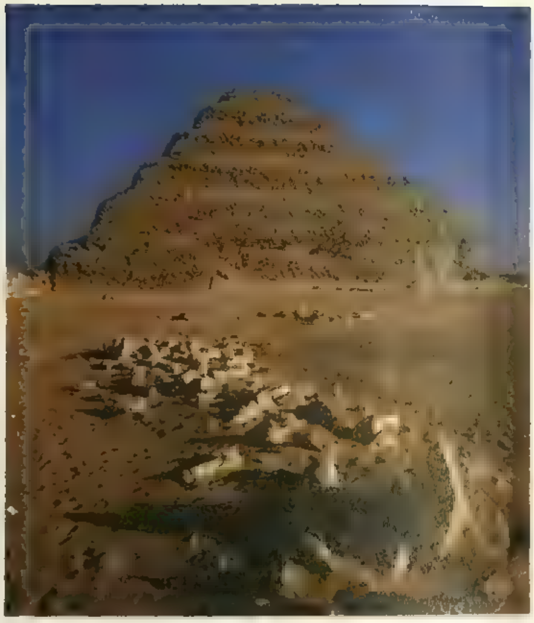
In this formula, $B$ stands for the area of the base and $h$ for the height of the pyramid.

For a regular pyramid, the altitude of any face is called the *slant height.* The formula used to determine the area of the faces *(L)* of a regular pyramid is

$$L = \frac{1}{2} Ps$$

Here, $P$ stands for the total length of the base's *perimeter* (outer boundary) and $s$ for the slant height.

**Pyramids** are large structures with square bases and four smooth, triangular-shaped sides that come to a point at the top. Several ancient peoples used pyramids as tombs or temples. The most famous pyramids are those built about 4,500 years ago as tombs for Egyptian kings. These Egyptian pyramids are among the Seven Wonders of the Ancient World.



**Pyramids** were built by several ancient peoples as tombs or temples. The Step Pyramid, *above,* stands at the site of the ancient city of Memphis, near Saqqarah, Egypt.

## Egyptian pyramids

The ruins of 35 major pyramids still stand near the Nile River in Egypt. Each was built to house the body of an Egyptian king. The Egyptians thought that a person's body had to be preserved and protected so the soul could live forever. The Egyptians *mummified* (embalmed and dried) their dead and hid the mummies in large tombs. From about 2700 to 1700 B.C., the bodies of Egyptian kings were buried inside or beneath a pyramid in a secret chamber that was filled with treasures of gold and precious objects. Many scholars believe that the pyramid shape had a religious meaning to the Egyptians. The sloping sides may have reminded the Egyptians of the slanting rays of the sun, by which the soul of the king could climb to the sky and join the gods.

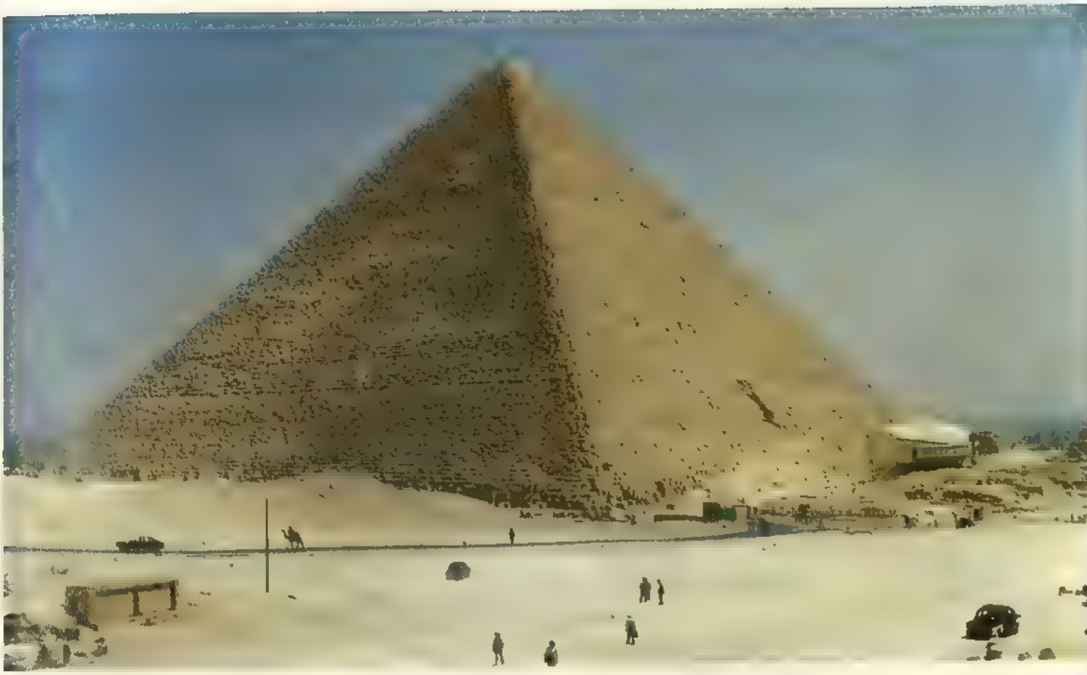
Funeral ceremonies were performed in temples that were attached to the pyramids. Most pyramids had two temples connected by a long stone passageway. Sometimes a smaller pyramid for the body of the queen stood next to the king's pyramid. Egypt has at least 40 smaller pyramids that were used for queens or as memorial monuments for kings. The king's relatives and officials were buried in smaller rectangular tombs called *mastabas,* which had sloping sides and flat roofs.

**The first pyramids.** Imhotep, a great architect and statesman, built the first known pyramid for King Zoser in about 2650 B.C. Zoser's tomb rose in a series of giant steps, or terraces, and is called the *Step Pyramid.* This pyramid still stands at the site of the ancient city of Memphis, near Saqqarah.

The first smooth-sided pyramid was built about 2600 B.C. It still stands at Medum. It began as a stepped pyramid, and then the steps were filled in with casing stones to give the building smooth, sloping sides. Other pyramids built during a period of Egyptian history called the Old Kingdom (2686-2181 B.C.) can be seen at Abusir and Dahshur. During the Middle Kingdom (2052-1786 B.C.), pyramids were built at Hawara, Illahun, Lisht, and Dahshur—near what is now Cairo. The remains of these pyramids are still impressive.

**The Pyramids of Giza** (Al Jizah) stand on the west bank of the Nile River outside Cairo (see Egypt [physical map]). There are 10 pyramids at Giza, including three of the largest and best preserved of all Egyptian pyramids. They were built for kings in about 2600 to 2500 B.C. The largest was built for King Khufu (called Cheops by the Greeks). The second was built for King Khafre (Chephren), and the third for King Menkaure (Mycerinus). A huge statue of a sphinx, called the Great Sphinx, was probably built for Khafre. It stands near his pyramid.

The pyramid of Khufu, called the *Great Pyramid,* contains more than 2 million stone blocks that average 2.3



**The Great Pyramid, built about 4,500 years ago, rises at Giza, near Cairo.**

metric tons each. It was originally 147 metres tall, but some of its upper stones are gone now and it stands about 140 metres high. Its base covers an area of about 5 hectares.

A study of the Great Pyramid shows how these gigantic structures were built. The ancient Egyptians had no machinery or iron tools. They cut big limestone blocks with copper chisels and saws. Most of the stones came from quarries nearby. But some came from across the Nile, and others came by boat from distant quarries. Gangs of men dragged the blocks to the pyramid site and pushed the first layer of stones into place. Then they built long ramps of earth and brick, and dragged the stones up the ramps to form the next layer. As they finished each layer, they raised and lengthened the ramps. Finally, they covered the pyramid with an outer coating of white casing stones. They laid these outer stones so exactly that from a distance the pyramid appeared to have been cut out of a single white stone. Most of the casing stones are gone now, but a few are still in place at the bottom of the Great Pyramid.

The burial chamber is inside the Great Pyramid. A corridor leads from an entrance on the north side to several rooms within the pyramid. One of the rooms is called the *Queen's Chamber,* although the queen is not buried there. The room was planned as the king's burial chamber. But Khufu changed the plan and built another burial chamber, called the *King's Chamber.* The *Grand Gallery,* a corridor 47 metres long and 8.5 metres high, leads to Khufu's chamber. The Great Pyramid is considered a marvel of ancient architecture.

No one knows how long it took to build the Great Pyramid. The ancient Greek historian Herodotus said that the work went on in four-month shifts, with 100,000 workers in each shift. Scholars now doubt that account and believe that about 100,000 men worked on the pyramids for three or four months each year. Farm labourers built the pyramids. They worked on the tombs during periods when floodwaters of the Nile covered the fields and made farming impossible.

Thieves broke into most of the pyramids, stole the gold, and sometimes destroyed the bodies. Later Egyptian kings stopped using pyramids, and built secret tombs in cliffs. But some kings of the Kushite kingdom in Nubia, south of Egypt, built pyramids long after they were no longer used in Egypt.

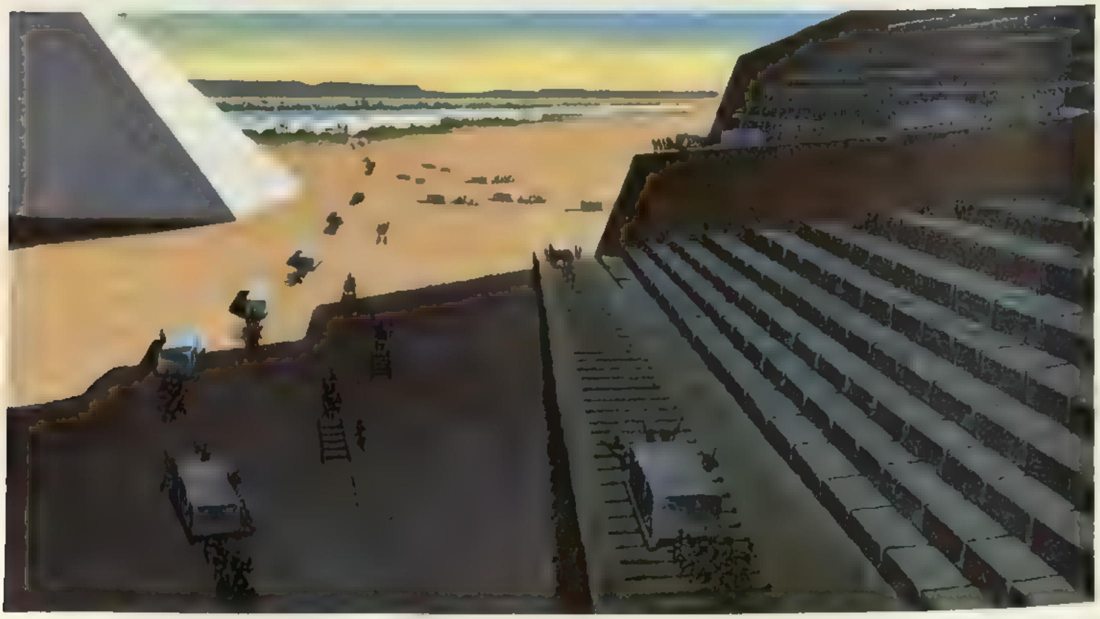
### American pyramids

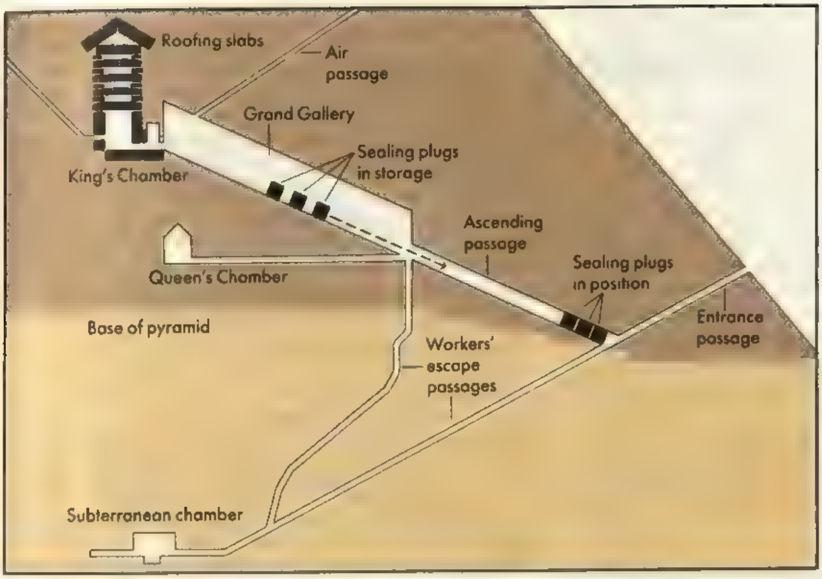
Several ancient peoples of Central and South America also built pyramids. They built stepped pyramids that had flat tops. They used the flat tops as platforms for their temples.

The Mochica of Peru built large brick pyramids. *The Temple of the Sun,* near what is now Trujillo, on Peru's northern coast, has a terraced brick pyramid on top of a stepped platform. The ancient Maya of Central America built pyramid-shaped mounds of earth with temples on top (see Maya [pictures]).

The Toltec of central Mexico also built big stepped pyramids. One of these pyramids, at Cholula, is one of the largest structures in the world. Peoples related to the Toltec built the great pyramids of the Sun and Moon that still stand at Teotihuacán, near Mexico City. The Spanish conquerors destroyed most pyramids of the later Aztec Empire in Mexico. These pyramids were built in steps or terraces like the other American pyramids, and had temples on top. Two of the greatest were at Tenochtitlán (now Mexico City). Mound-building

**Building the pyramids** was a great engineering feat requiring thousands of workers. First, workers cut and shaped huge limestone blocks using chisels and saws, *above.* Groups of workers dragged the blocks to the pyramid site on sledges and pulled them up ramps on the pyramid, *below.* Planks on the ramps lessened the friction of the sledges. As the pyramid grew taller, workers extended the ramps. Over 2 million blocks were used in building the Great Pyramid at Giza.






**A cross section of the Great Pyramid** shows the Grand Gallery, the King's Chamber, the Queen's Chamber, and various passages. After the burial, large blocks called sealing plugs were allowed to slide down the passageway from the Grand Gallery to seal off the tomb. Workers left the tomb through an escape passageway.

peoples of North America built some pyramid-shaped mounds, but they were not true pyramids.

See also **Egypt** (picture: The Nile Valley); **Egypt, Ancient** (pictures); **Mexico** (picture: Ancient pyramids).

**Pyramus and Thisbe** are young lovers in an ancient legend. Pyramus and Thisbe lived next door to each other in Babylon. They fell in love, but their parents would not let them marry or even spend time with each other. They had to talk through a crack in the wall between their houses.

Finally, they planned to meet at night under a mulberry tree outside the city. Thisbe arrived first. She was frightened by a lioness that had bloody jaws from killing an animal. The frightened Thisbe ran away, dropping her veil as she fled. The lioness tore the veil apart with its bloody mouth. Pyramus then arrived and saw the tracks of the lioness and the blood on the veil. He thought Thisbe had been killed and stabbbed himself in grief. Thisbe returned to the scene and found Pyramus dead. She then stabbed herself with his dagger.

The Roman poet Ovid told the story of Pyramus and Thisbe in his *Metamorphoses.* William Shakespeare's play *A Midsummer Night's Dream* includes an amateur theatre group that performs a comic adaptation of the legend.

**The Pyramid of the Sun** at Teotihuacán, Mexico, had a larger base than the largest pyramid in Egypt.

**Pyrenean sheepdog** is the smallest of four breeds of French sheepdogs. It was bred and developed in the Pyrenees to herd sheep, and to act as the farm guard dog. Before the 1920's, the breed was little known outside its native mountain home. The Pyrenean sheepdog is highly intelligent, agile, and has great energy. It stands 40 to 50 centimetres high at the shoulder, and weighs about 20 kilograms. It has a lively, expressive face. Its eyes are medium-sized and dark brown, and it has short, upright ears. The coat is long, dense, and may be wavy or curled. The Pyrenean sheepdog is usually fawn or grey/black in colour and may have white markings on the chest. See also **Great Pyrenees.**

**Pyrenees** is a mountain chain that forms a natural barrier between France and Spain. The mountains extend about 435 kilometres, from the Bay of Biscay to the Mediterranean Sea (see **Spain** [map]). They cover an area of over 52,000 square kilometres. Their average height is 1,070 metres, but many peaks in the central ranges rise over 3,000 metres. The highest point is Pico de Aneto (3,404 metres).

Glacier fields are found on the northern slopes of the Pyrenees. Minerals in the Pyrenees include iron, lead, silver, and cobalt. The iron mines near Bilbao, Spain, at the Biscay end of the Pyrenees, are a prosperous industry. There are forests of fir, pine, and oak on the mountains.

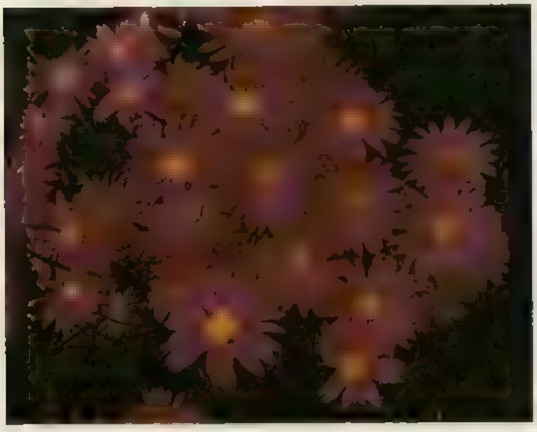
The Pyrenees chain is a barrier to overland commerce, and France and Spain have had to trade with each other chiefly by sea for many years. Several roads cut through the mountains. Two railways cross them. The first runs between Pau, France, and Saragossa, Spain, by way of the Canfranc Tunnel. The second runs between Toulouse, France, and Barcelona, Spain. This line climbs to a height of 1,580 metres. There are more than 40 tunnels in a 92-kilometre central section of the

Pyrenees. Several resorts are on the northern slopes. The small principality of Andorra is on the south slope of the eastern Pyrenees. The Basques live in the western Pyrenees.

See also **Andorra; Basques; Spain** (picture).

**Pyrethrum** is the name of a group of flowers, native to southwestern Asia, that give us an insect powder and medicine. The flower heads of the pyrethrum grow singly or in clusters on erect stems that rise 30 centimetres or more. They look like daisies with pink, white, crimson, or lilac rays. They bloom in spring or early summer, and are grown as garden flowers or for cutting.

The insecticide is made from the dried and powdered flowers. There are two types, Persian powder and Dalmatian powder, made from different pyrethrums. Pyrethrum, in its pure form or in a mixture, is the least poisonous insecticide to animals and people. It is used in liquids, powders, and sprays for insect control on animals, in the garden, and in the home. Kenya is the world's largest exporter of the pyrethrum extract used in making insecticides.



**Pyrethrums** are colourful garden plants. They grow best in well-drained soil in an open, sunny position.

A pyrethrum known as feverfew has been used as a tonic. A sedative for neuralgia, toothache, and headaches is also called pyrethrum. It is made from the root of a related plant called *pellitory,* which grows in the Mediterranean region and the Middle East. It is grown commercially in Algeria.

**Scientific classification.** Pyrethrums belong to the family, Compositae (Asteraceae). Persian powder is made from *Chrysanthemum coccineum.* Dalmatian powder is made from *C. cinerariaefolium.* Feverfew is *C. parthenium.* Pellitory is *Anacyclus pyrethrum.*

See also **Feverfew.**

**Pyridoxine.** See **Vitamin** (Vitamin B complex).

**Pyrite,** or "fool's gold," as it is sometimes called, is a compound of iron and sulphur, $FeS_2$. Another name for it is iron pyrite. Pyrite is found in many places and is often mistaken for gold. It can be distinguished from gold by heating it. Real gold will not react when heated, but pyrite will smoke and produce a bad odour. Pyrite is used to make sulphuric acid. The name *pyrite* comes from the Greek word for fire. When pyrite is struck with a hammer, sparks are produced. In the past, some American Indians and members of a number of other cultures used pyrite to make fire.

See also **Mineral** (picture: Common minerals with metallic lustre).

**Pyroceram.** See **Glass** (Glass-ceramics).

**Pyromania** refers to an uncontrollable urge to start fires. A pyromaniac experiences tension or arousal prior to starting a fire, and relief or gratification when starting or witnessing a fire. Some pyromaniacs feel sexual excitement from starting a fire. Others experience a release of hostile feelings. Pyromaniacs do not start fires for financial gain or political reasons, or in response to delusions or hallucinations. Pyromania is much more common in males than in females. It usually begins in childhood. See also **Arson.**

**Pyrometer.** See **Pyrometry.**

**Pyrometry** is a system of measuring temperatures. It usually refers to temperatures that are too high to be measured by ordinary thermometers. In pottery kilns, where it is necessary to measure not only the temperature, but also the effect of the heat, *pyrometric,* or *Seger, cones* are sometimes used. These small pyramid-shaped cones are made of clay and salt, and will melt after being at a certain temperature for a given length of time. Unfired rings of clay are also used in kilns to measure the work done by heat.

*Pyrometers* are used when it is necessary to measure only the high temperature. One kind matches the colour in the furnace against known temperatures of red-hot wires. A thermoelectric pyrometer is used when the temperature is to be recorded graphically, and for automatic temperature control. Pyrometry is important in heat-treating metals and in making glass.

**Pyrosis.** See **Heartburn.**

**Pyroxene** is any of a group of minerals that play an important part in the formation of many kinds of rocks. Pyroxenes occur widely in the continental and oceanic crusts of the earth, as well as in many of the rocks of the moon's outer crust.

Most pyroxenes are the direct product of igneous and metamorphic processes of rock formation (see **Rock** [Igneous rock; Metamorphic rock]). Geologists study pyroxenes that have crystallized from *magma* (molten rock material) and, by doing so, they have learned much about the changes undergone by rocks that have formed from magma.

Pyroxenes range in colour from greenish black and reddish brown to colourless. All pyroxenes have the same *silicate structure.* In this structure, a silicon atom at the centre with four oxygen atoms attached forms a *tetrahedron,* a pyramidlike figure with four triangular faces. These groups of atoms band together in a single chain, with two of the four oxygen atoms connecting to adjacent tetrahedra. The chains, in turn, are linked together by positively charged atoms called *cations* within the *unit cell* of a pyroxene (see **Mineral** [Inside minerals]).

Cations of different elements affect the arrangements of the chains within the crystal structures. With a calcium, sodium, or other large cation present, the crystals form a *monoclinic* pattern (see **Crystal**). These pyroxenes are called *clinopyroxenes.* With a small cation, such as iron or magnesium, the crystals form an *ortho-*

*rhombic* pattern. These pyroxenes are called *orthopyroxenes.*

The most common clinopyroxenes are augites, diopsides, and pigeonites. The most common orthopyroxenes are bronzites and hypersthenes.

**Pyroxylin.** See **Plastics** (The invention of celluloid).

**Pyrrha.** See **Deucalion.**

**Pyrrhic victory.** See **Pyrrhus.**

**Pyrrho of Elis** (361?-270? B.C.) was the founder of Scepticism, a philosophical movement of ancient Greece. He travelled widely and learned many different philosophic viewpoints, each one claiming to be the truth. Because they could not all be right, Pyrrho decided to suspend judgment about truth, right, and wrong. Custom and convention, he felt, were the only guides to what is just or unjust. Even our senses tell us only how things appear, not what they really are. Pyrrho was born at Elis, Greece.

See also **Scepticism.**

**Pyrrhotite.** See **Mineral** (picture).

**Pyrrhus** (318?-272 B.C.) was a king of Epirus in Greece. His name has lived in the expression "Pyrrhic victory." It is used to refer to a victory that has cost more than it is worth. The expression arose from a remark that Pyrrhus used after fighting the battle of Asculum in which he lost almost all his men. He exclaimed, "Another such victory and I shall be ruined."

Pyrrhus was a second cousin of Alexander the Great, the king of Macedonia. Pyrrhus was born in Epirus. His father was king of Epirus. However, he lost his throne and was killed when his son was two years old. Pyrrhus was put on the throne at the age of 12, but at 17 he lost it. Later Pyrrhus went to Egypt where he served King Ptolemy.

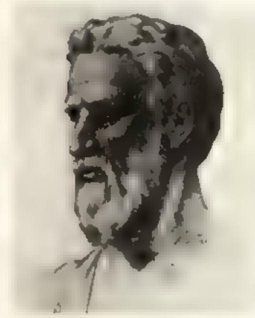
Pyrrhus raised an army and returned to his native country. He recovered his throne, and then tried to conquer Macedonia. In 287 B.C., Pyrrhus became king of Macedonia. However, he lost his throne again the following year.

Tarentum, a Greek colony in lower Italy, and its neighbours appealed to Pyrrhus in 281 B.C. for aid against the Romans. Pyrrhus sent 25,000 men and 20 elephants. His forces conquered the Romans, chiefly because of the use of elephants in the battle.

Pyrrhus later helped the Greeks of Sicily against the Carthaginians. In this war he was successful at first. But Pyrrhus soon began to lose, and finally he was driven out of Sicily in 276 B.C. Two years later the Romans defeated him and forced him to return to Epirus. The next year Pyrrhus invaded Macedonia again, and once more he was hailed as king. In 272 B.C., he marched south and made an unsuccessful attack on Sparta. Pyrrhus was killed in a battle with Antigonus Gonatus while trying to capture Argos.

**Pythagoras** (580?- ? B.C.) was a Greek philosopher and mathematician. Pythagoras was famous for formulating *Pythagoras' theorem,* but its principles were known earlier (see **Pythagoras' theorem**).

As a philosopher, Pythagoras taught that number was the essence of all things. He mystically associated numbers with virtues, colours, and many other ideas. Pythagoras also taught that the human soul is immortal and that after death it moves into another living body, sometimes that of an animal. This idea is called *transmigration of the soul.* It appears in many early religions and is still the belief of many of the Hindu sects of India. Pythagoras may have obtained some of his ideas during travels in the East.



**Pythagoras**

Pythagoras believed that the earth was spherical and that the sun, moon, and planets have movements of their own. His successors developed the idea that the earth revolved about a central fire. This belief anticipated the Copernican system (see **Copernicus, Nicolaus**).

Little is known of Pythagoras' early life, but scholars believe that he was born on the island of Samos. In about 529 B.C., he settled in Crotona, Italy. Pythagoras founded a *school* (brotherhood) among the aristocrats of that city.

The people of Crotona were suspicious of the Pythagorean brotherhood because its members were aristocrats. The people killed most of the members of the brotherhood in a political uprising. Historians do not know whether Pythagoras left Crotona some time before the outbreak of violence and escaped death there, or was killed in it.

**Pythagoras' theorem,** in geometry, states that in a right-angled triangle the square of the hypotenuse equals the sum of the squares of the other two sides. A right-angled triangle is one in which one angle equals 90°. The hypotenuse is the side opposite the right angle. The theorem written as a formula is:

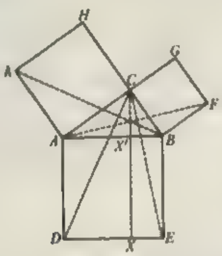
$$c^2=a^2+b^2$$

In this formula, $c$ is the length of the hypotenuse, and $a$ and $b$ are the lengths of the other two sides. If you know any two sides of a right-angled triangle, you can substitute those two values in the formula and find the length of the missing side.

**Origins.** The ancient Egyptians wanted to lay out square (90°) corners to their fields. They had few of the tools we have today. How could they make a 90° angle? About 2000 B.C., they discovered a "magic 3—4—5" triangle. Workmen took a loop of rope knotted into 12 equal spaces. They took three stakes and stretched the rope to form a triangle around the stakes. They placed the stakes so the triangle had sides of 3, 4, and 5 units. The side of 5 units was what we could call the hypotenuse, and the angle opposite it equalled 90°.

The ancient Greeks learned this trick from the Egyptians. Between 500 and 350 B.C., a group of Greek philosophers called the Pythagoreans explored the 3—4—5 triangle. They learned to think of the triangle's sides as the sides of three squares. The area of a square is a side multiplied by itself. In the 3—4—5 triangle, the area of a square of which the hypotenuse is a side equals the sum of the areas of the squares of the other two sides: $5\times5=3\times3+4\times4$. Then the Pythagoreans generalized this rule about the 3—4—5 triangle to apply to *all* right-angled triangles. This general statement became Pythagoras' theorem.

**Euclid's proof.** In formal geometry, Pythagoras' theorem has had many proofs. One of the most famous proofs belongs to the Greek mathematician Euclid (c. 300 B.C.). In this drawing, *ABC* is the original right-angled triangle:




The squares are drawn for each side, and the right angle is at *C*. How can we prove that the square on the hypotenuse equals the other two squares?

Here are the steps in Euclid's proof. The reasons for each step come from axioms, postulates, and other theorems in geometry. First, by a series of statements, you show that the area of the square on side *AC* is twice the area of triangle *ABK*. Next, you show that triangles *ABK* and *ACD* are *congruent* (corresponding). Third, you show that the area of rectangle *ADXX'* equals twice the area of triangle *ACD*. Therefore, the area of the square on side *AC* equals the area of rectangle *ADXX'*.

In the same way, you show that the area of the square on side *BC* equals the area of rectangle *BX'XE*. Finally, because the square on the side *AB* is equal to the sum of its parts (*ADXX'* and *BX'XE*), it is equal to the sum of the squares on the other two sides.

**Pytheas** was a Greek explorer who lived in the late 300's B.C. Pytheas slipped by a blockade set up by the Carthaginian navy at Gibraltar in order to explore the northern coasts of Europe. He sailed around Britain, and explored that area. Pytheas heard stories of a mysterious land called Thule, which was probably Norway.

Pytheas was a great navigator. He knew that the North Star is not directly above the North Pole. He also realized that the moon has something to do with sea tides. Many Greek scientists doubted his honesty. However, later discoveries showed that he was telling the truth about the things he had seen. Pytheas was born in Massalia (now Marseille, France).

See also **Exploration** (The ancient Greeks).

**Pythias.** See **Damon and Pythias.**

**Python** is a large snake that lives in southeastern Asia, India, the East Indies, Africa, and Australia. Some pythons are among the world's largest snakes. The *reticulate python* of southeastern Asia and the East Indies and the *African rock python* may grow 9 metres long. Only the giant anaconda of South America rivals these pythons in length. The *amethystine python* of Australia and the East Indies and the *Indian python* of southeastern Asia and India grow to about 6 metres long. The Australian *children's python* is less than 1 metre long.

Pythons are *constrictors,* which squeeze their prey to death. They wind themselves around the victim and tighten their coils. Pythons do not squeeze hard enough to break the victim's bones or to change its shape. They squeeze just enough to stop the victim's breathing and blood circulation. Large pythons usually eat small animals about the size of a domestic cat. But they may kill larger animals, such as wild pigs that weigh about 45 kilograms. Pythons swallow their prey whole. It may take a python many days to digest a large victim.

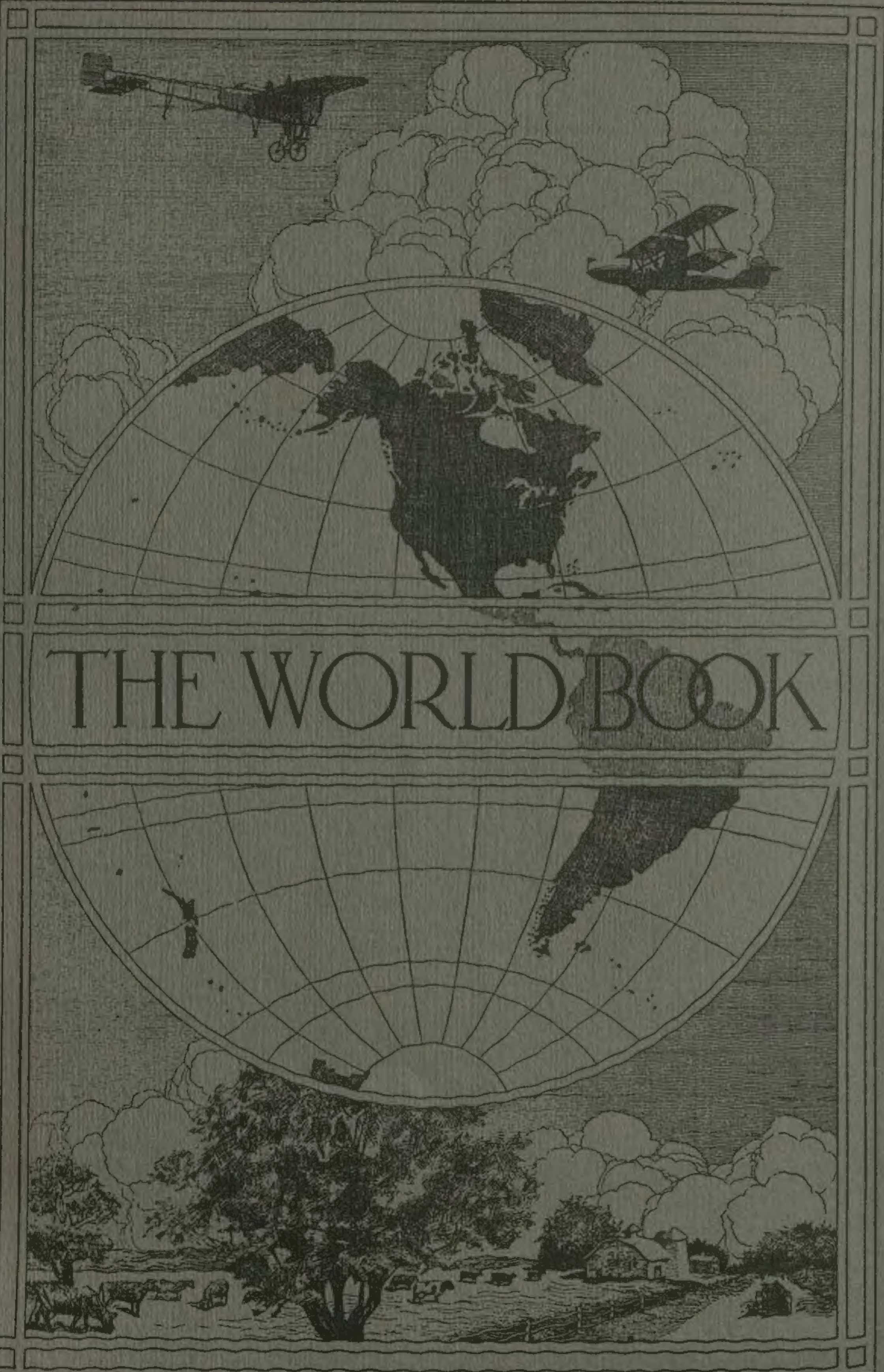
Pythons live in rugged tropical regions that have heavy rainfall and forests, or low, dense thorny scrub. Almost all pythons swim and climb well. There are also three *species* (kinds) of small burrowing pythons. One of these is the Mexican burrowing python, which is the only python found in the Americas.

Like most snakes, pythons hatch from eggs. The number of eggs in the nest varies greatly. Some may have about a hundred eggs. The female python coils about her eggs until they hatch. The Indian python *incubates* her eggs, or keeps them warm with heat from her body. Incubation, which is very unusual in snakes, helps the eggs hatch more quickly.

**Scientific classification.** Pythons belong to the python and boa family, Boidae. The reticulate python is *Python reticulatus.* The African rock python is *P. sebae,* the Indian python, *P. molurus,* the amethystine python, *P. amethystinus,* the children's python, *Liasis childreni,* and the Mexican burrowing python, *Loxocemus bicolor.*

See also **Boa constrictor; Snake** (pictures).

**The Indian python grows to about 6 metres in length.**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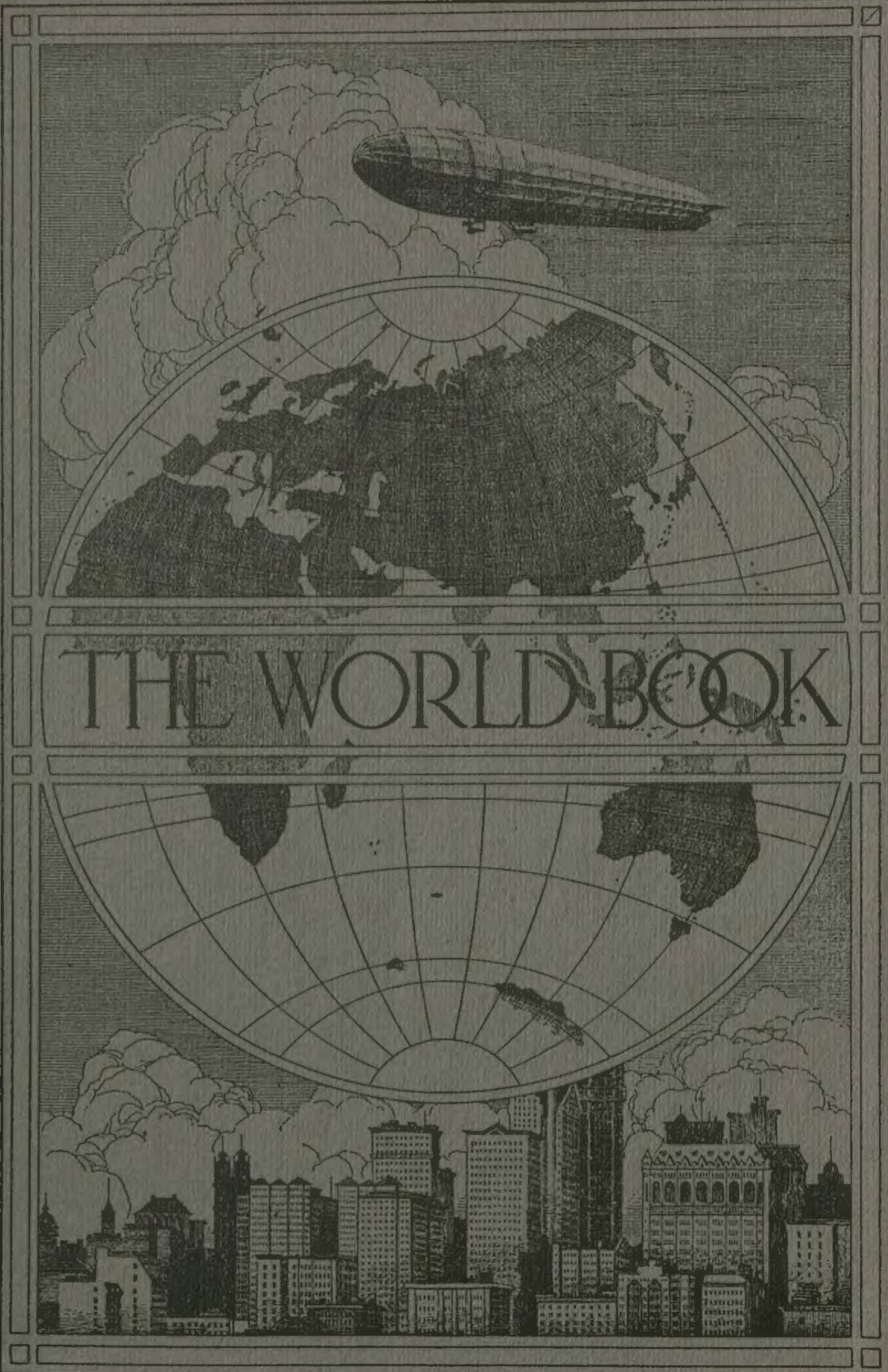
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